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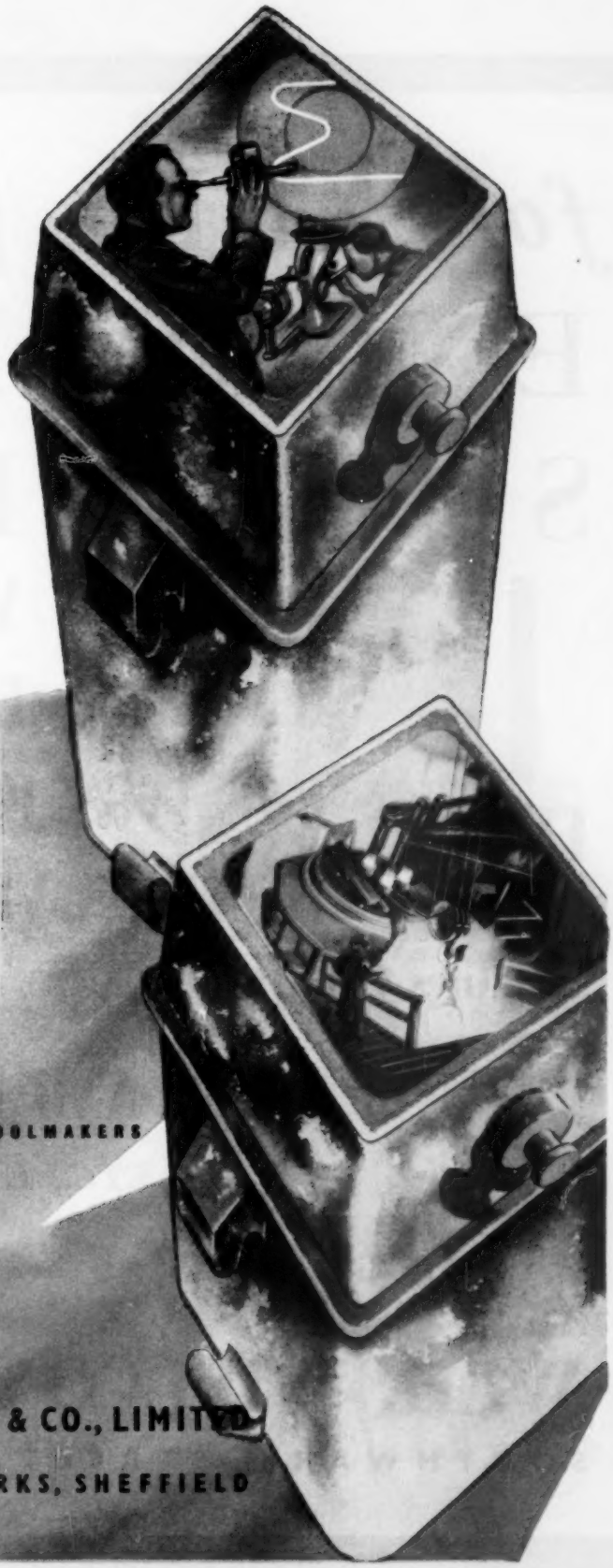

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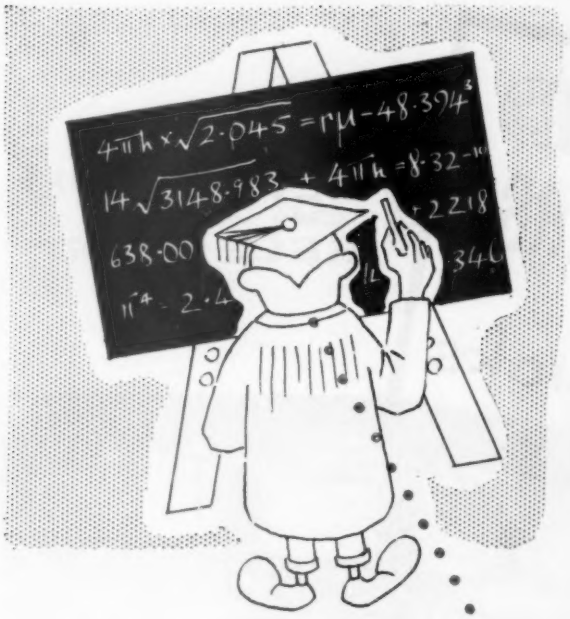

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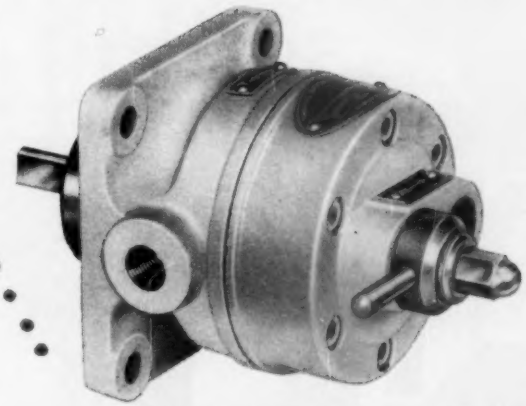

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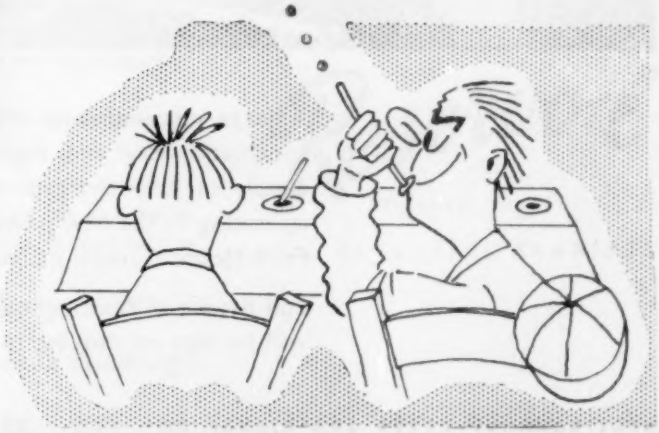

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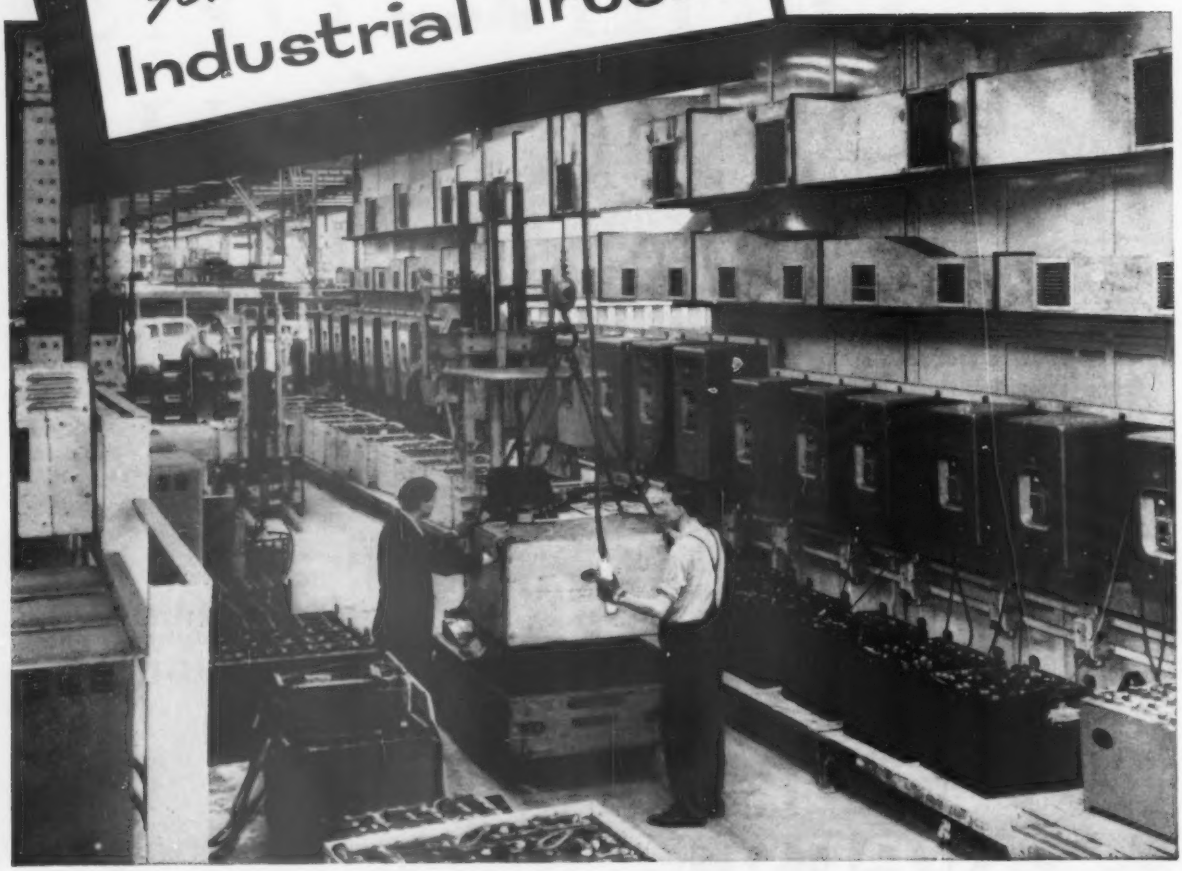

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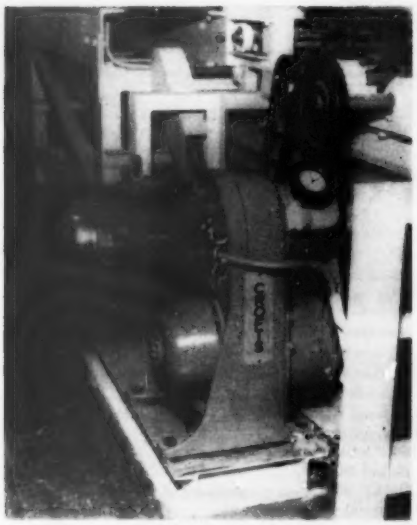

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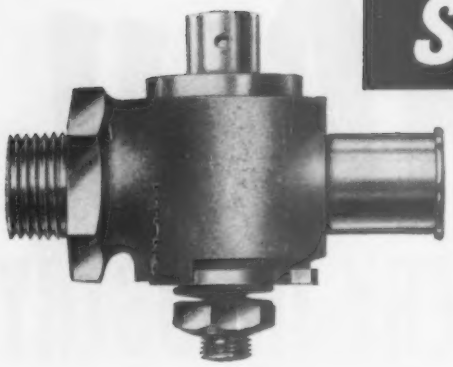

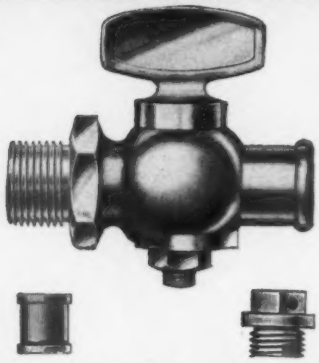

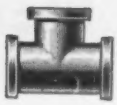

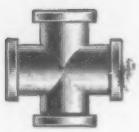

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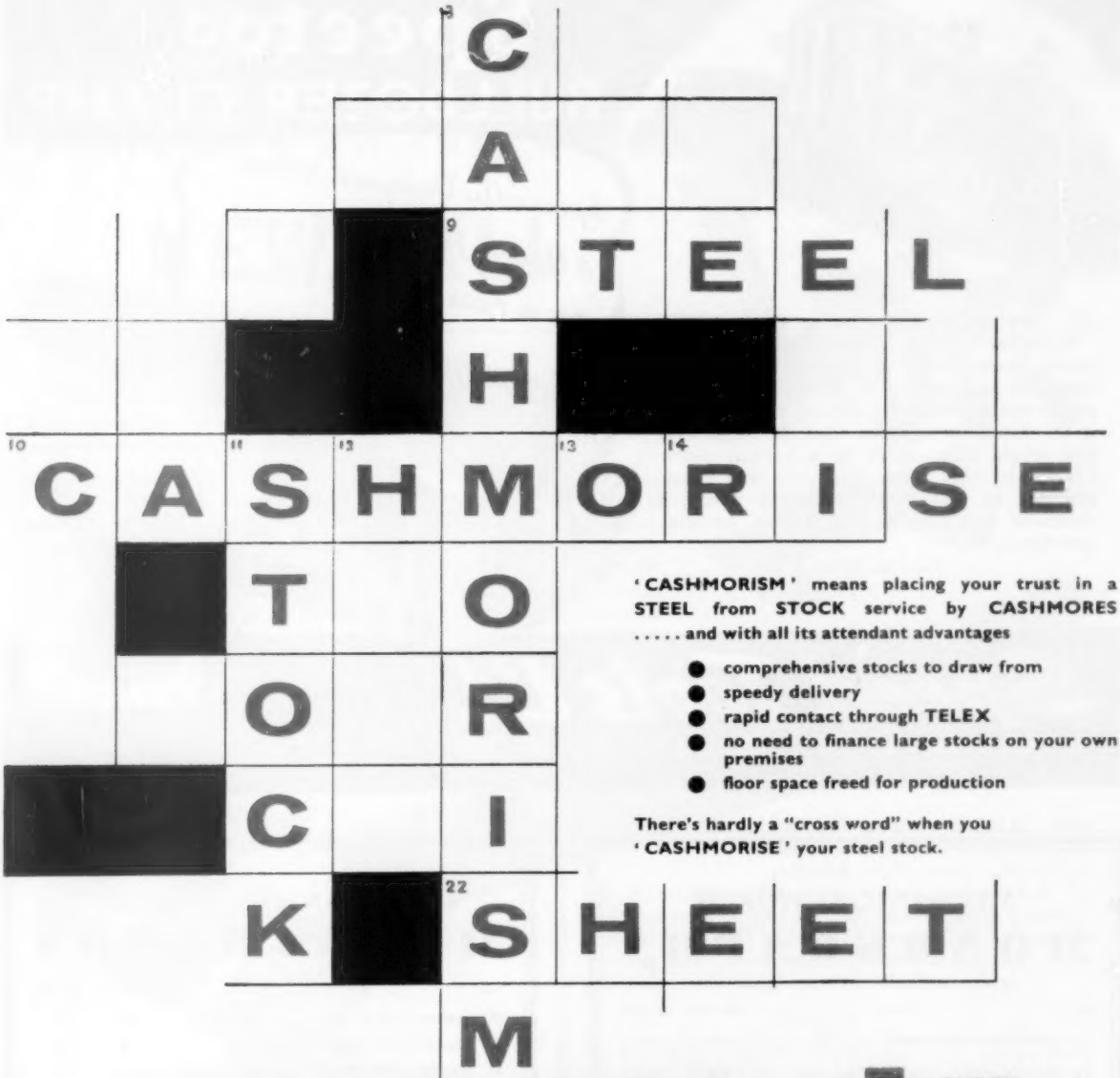

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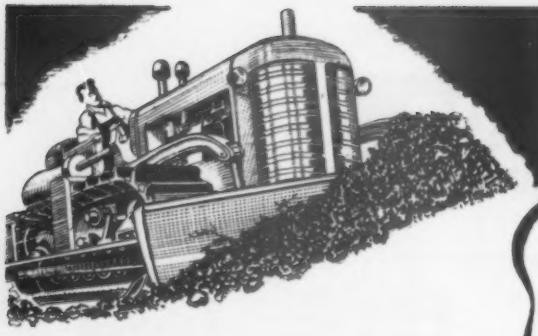

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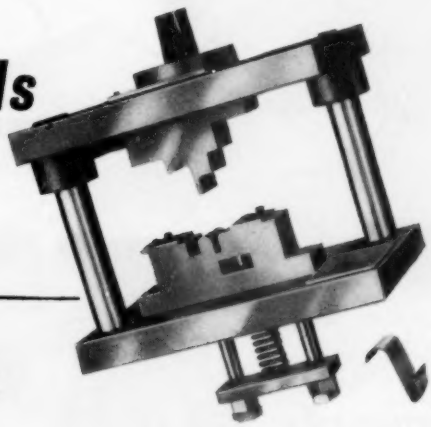

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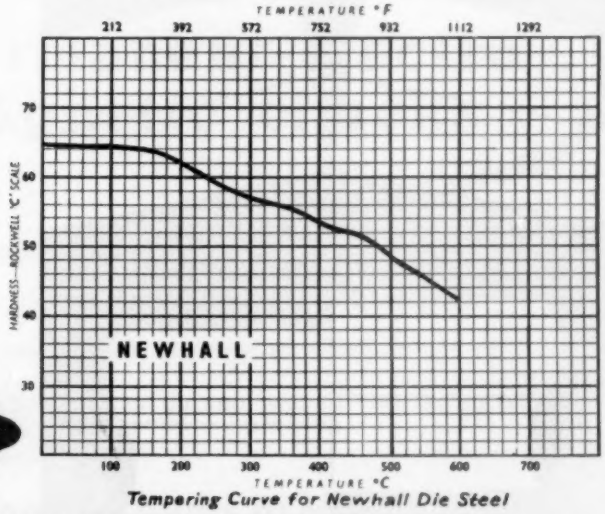

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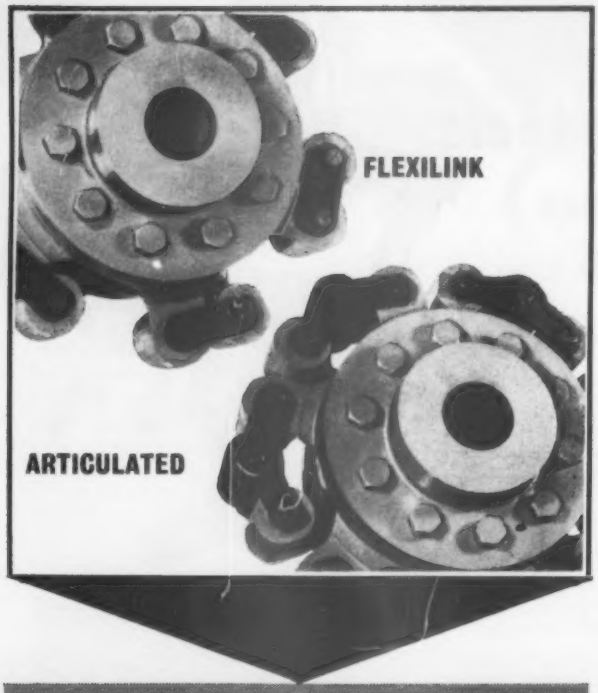

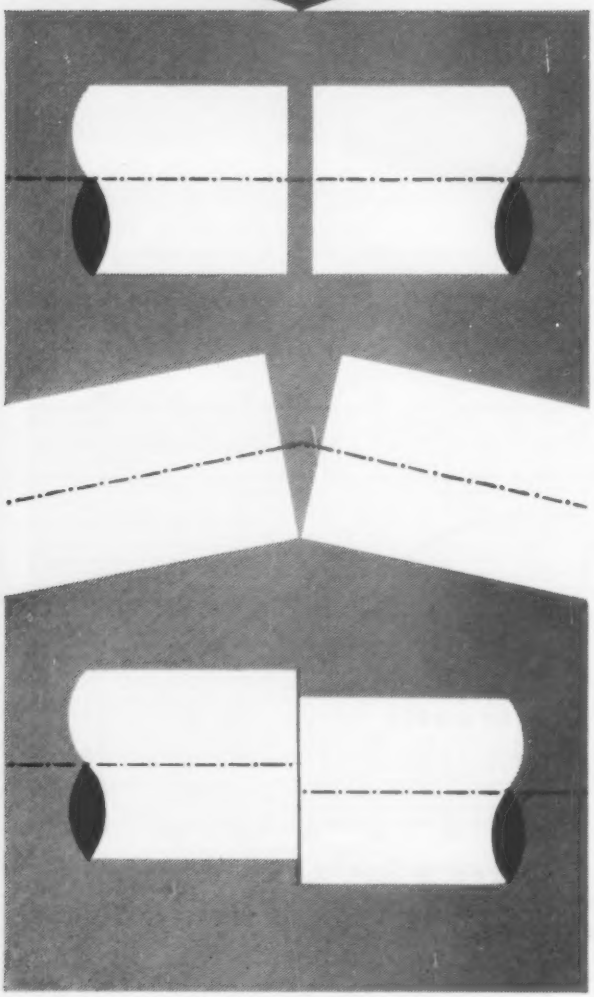

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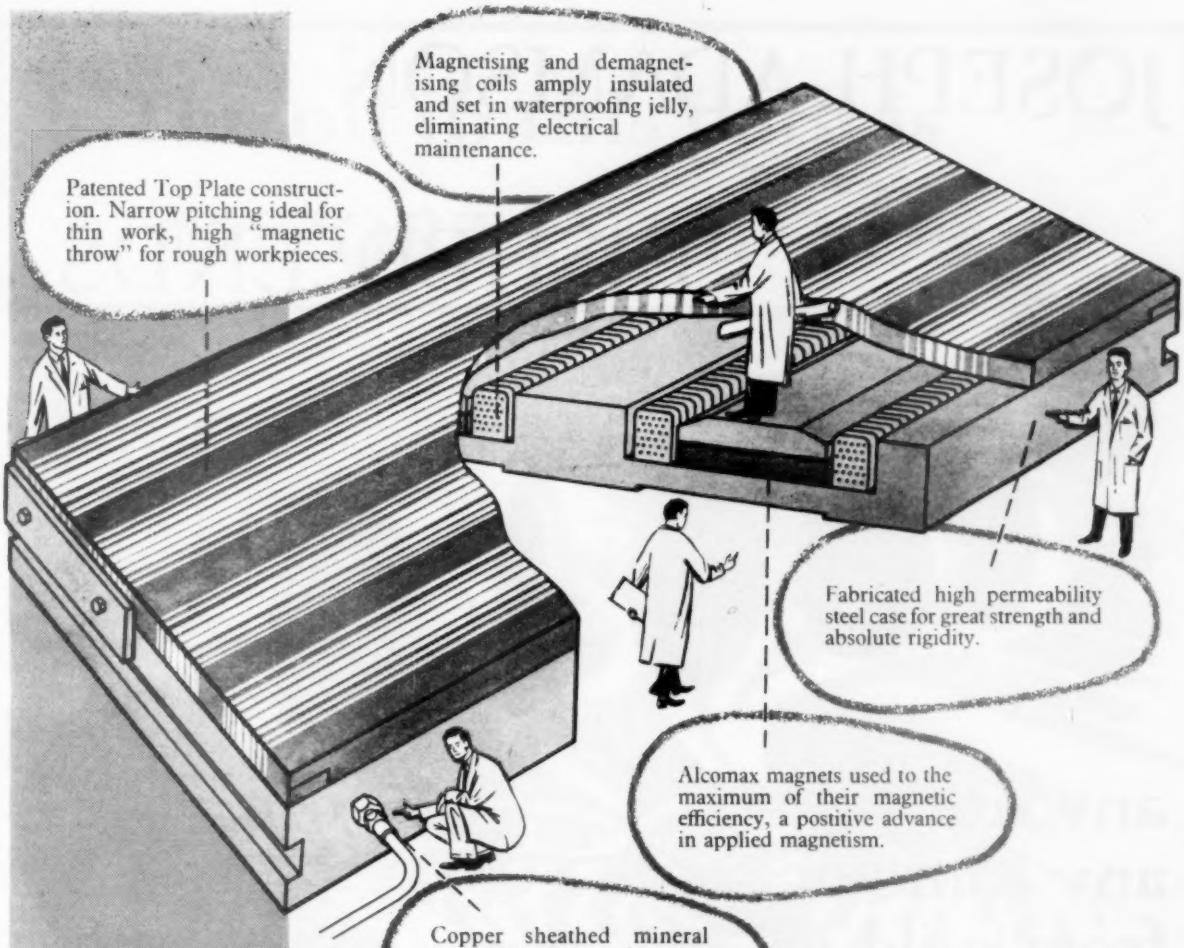
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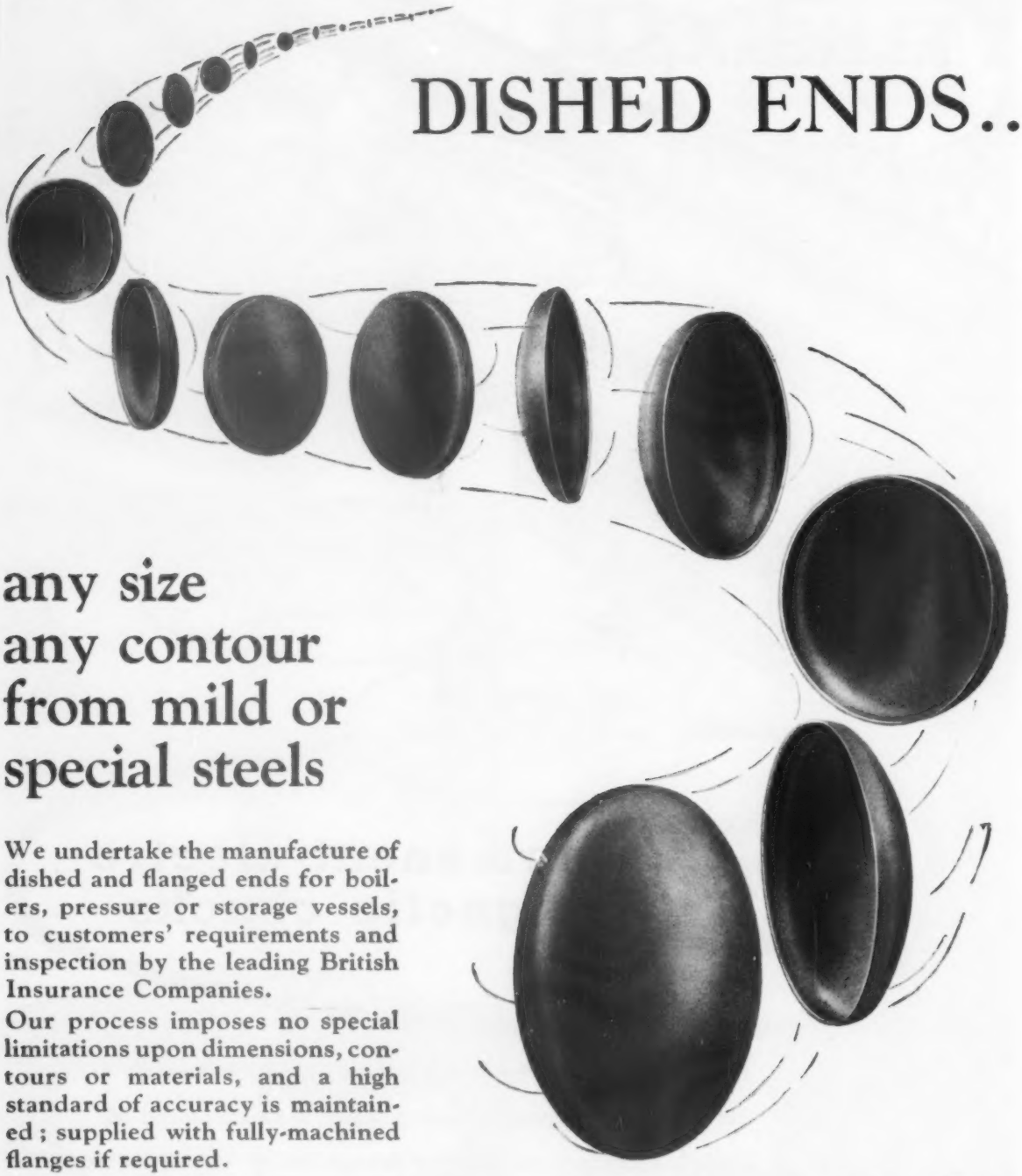

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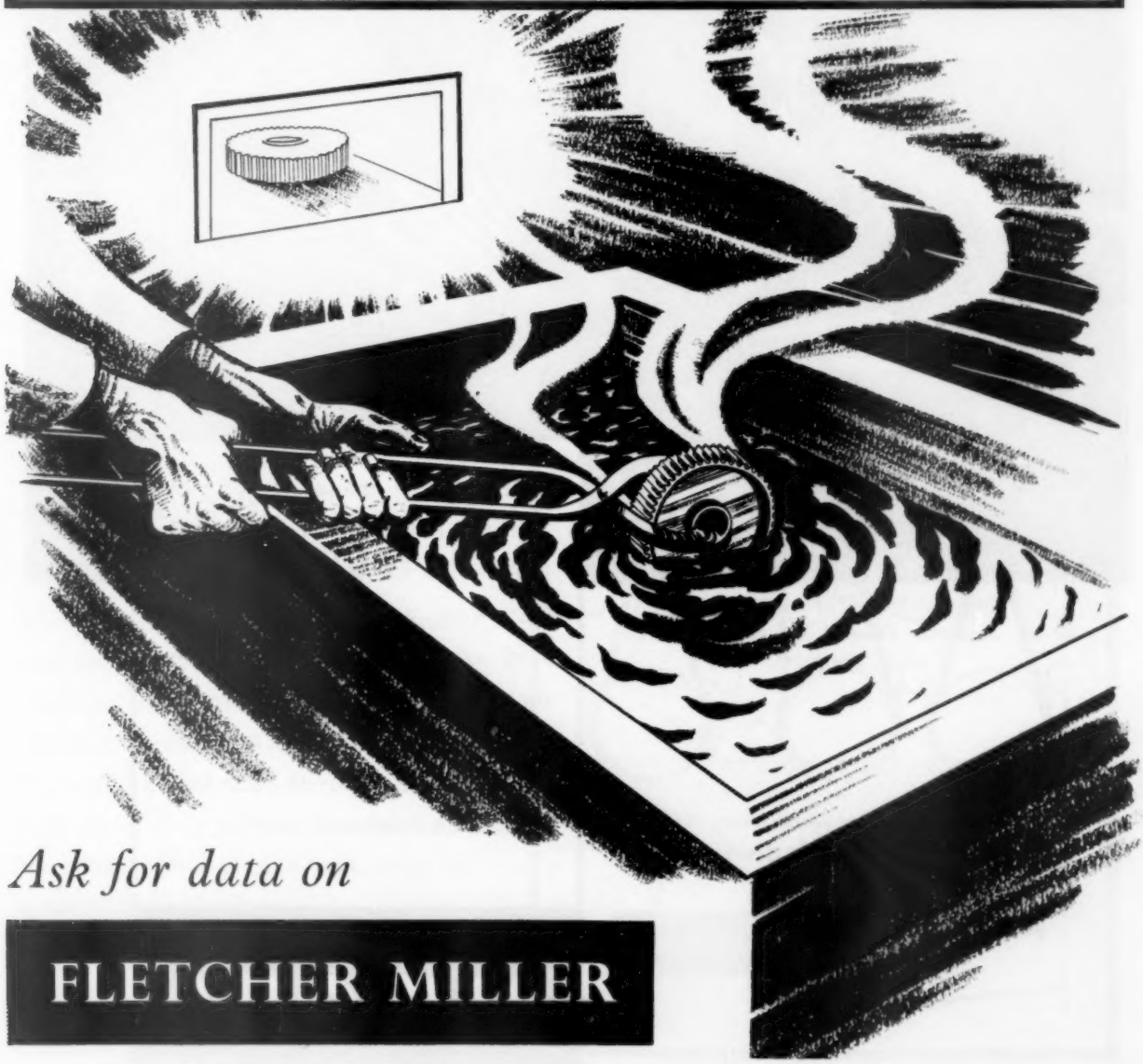

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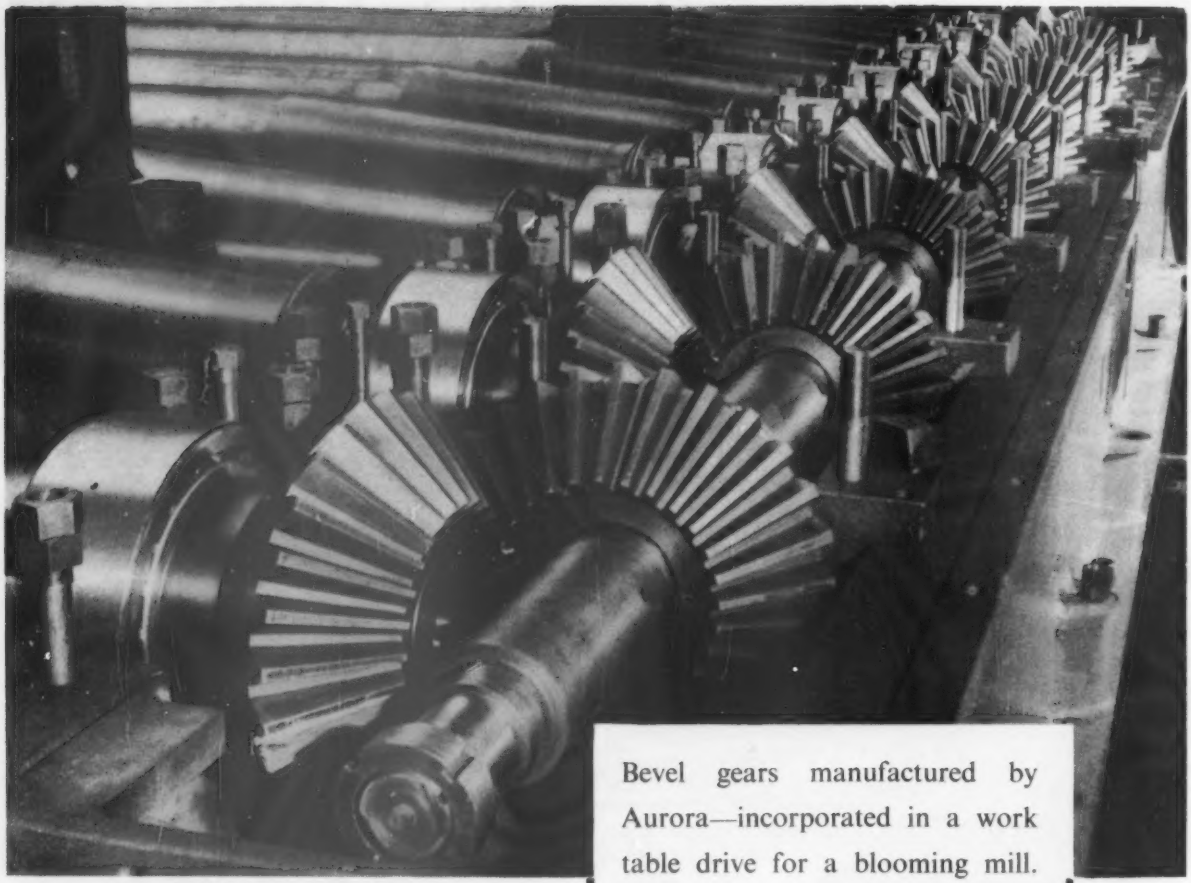

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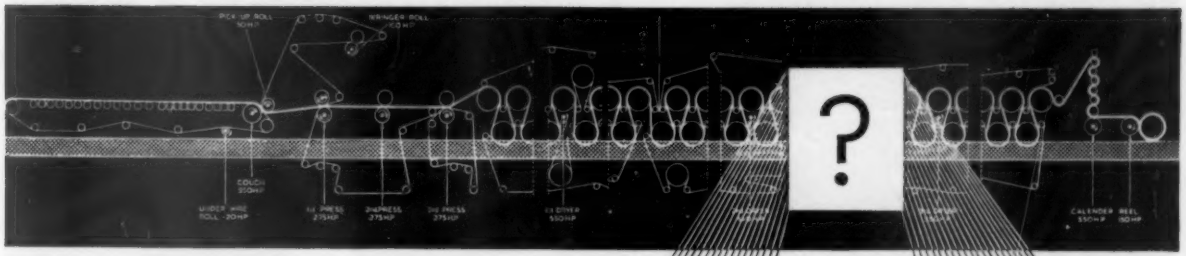
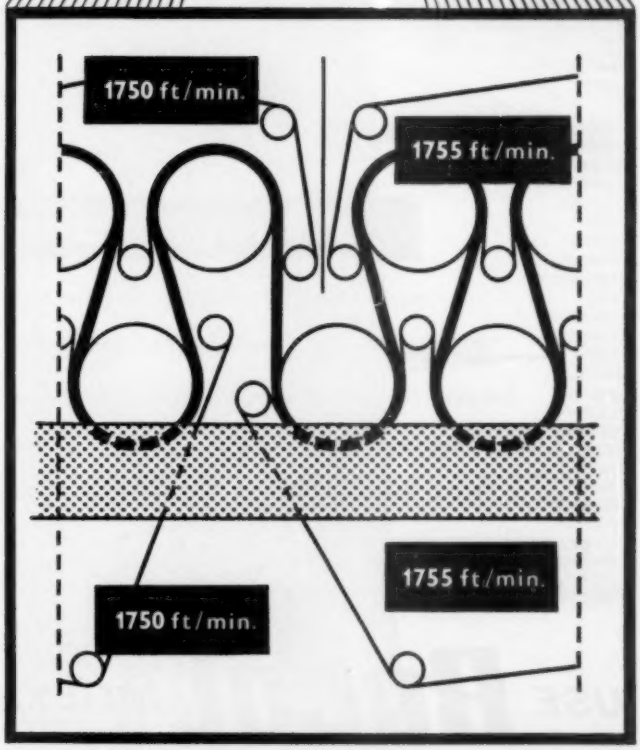


A TYPICAL PROBLEM

The importance of accurate differential speeds in sectional paper machine drives is one of the many specialised industrial problems of which AEI has extensive practical knowledge.



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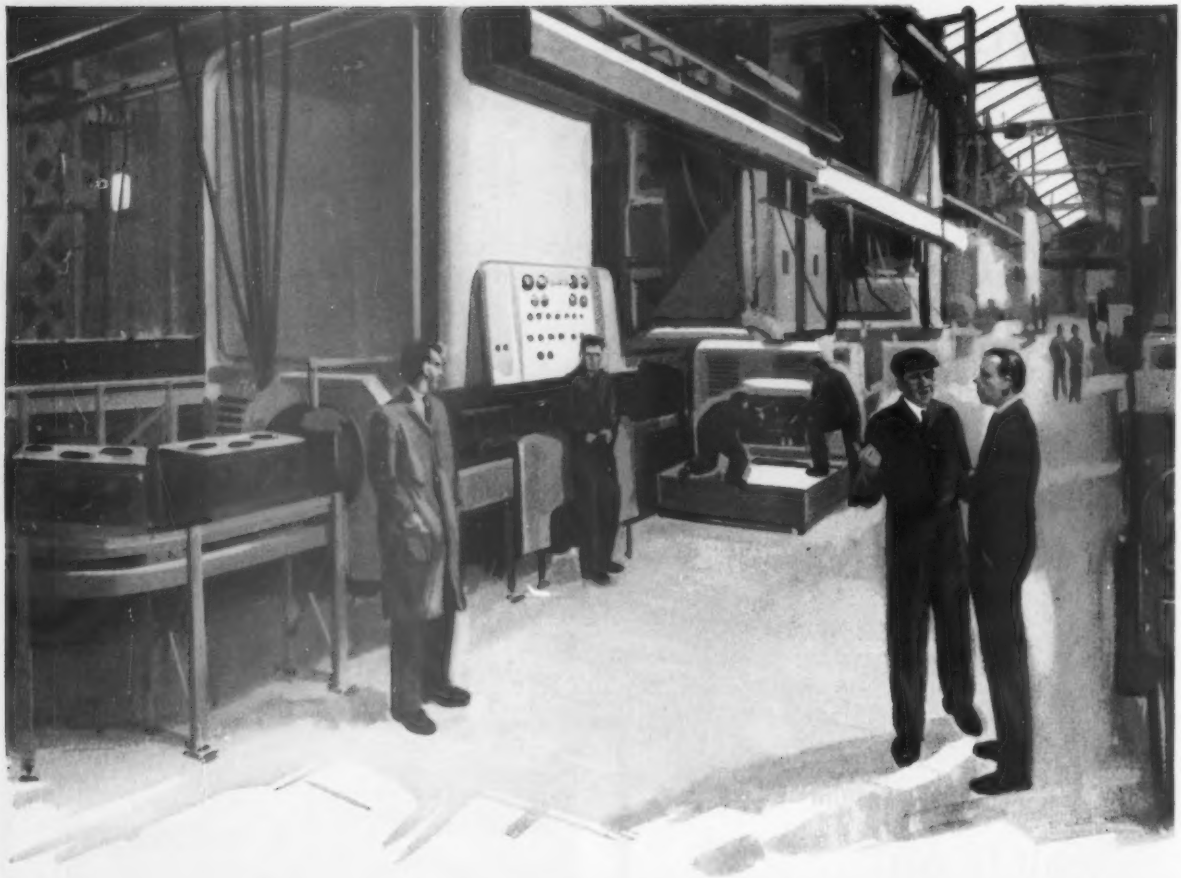

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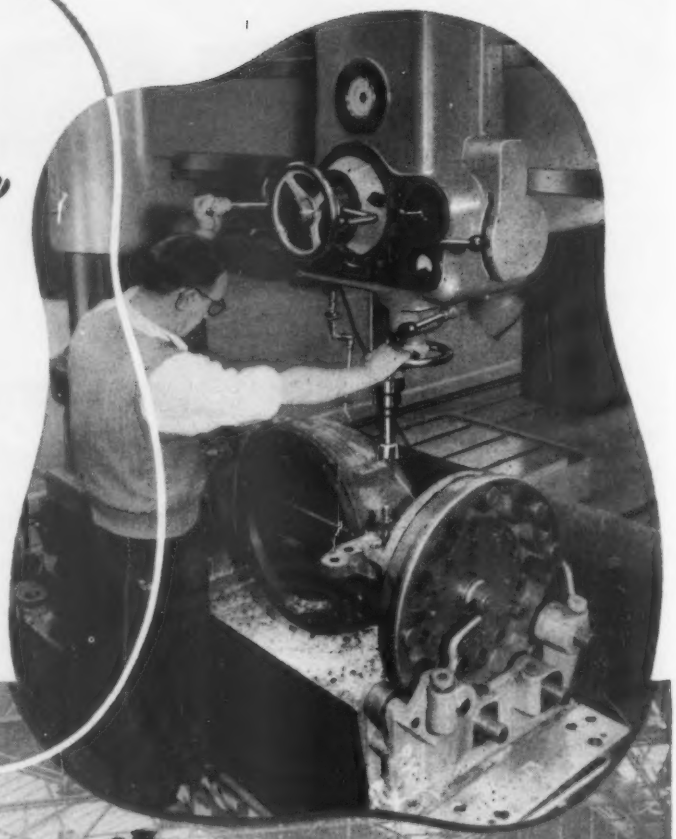

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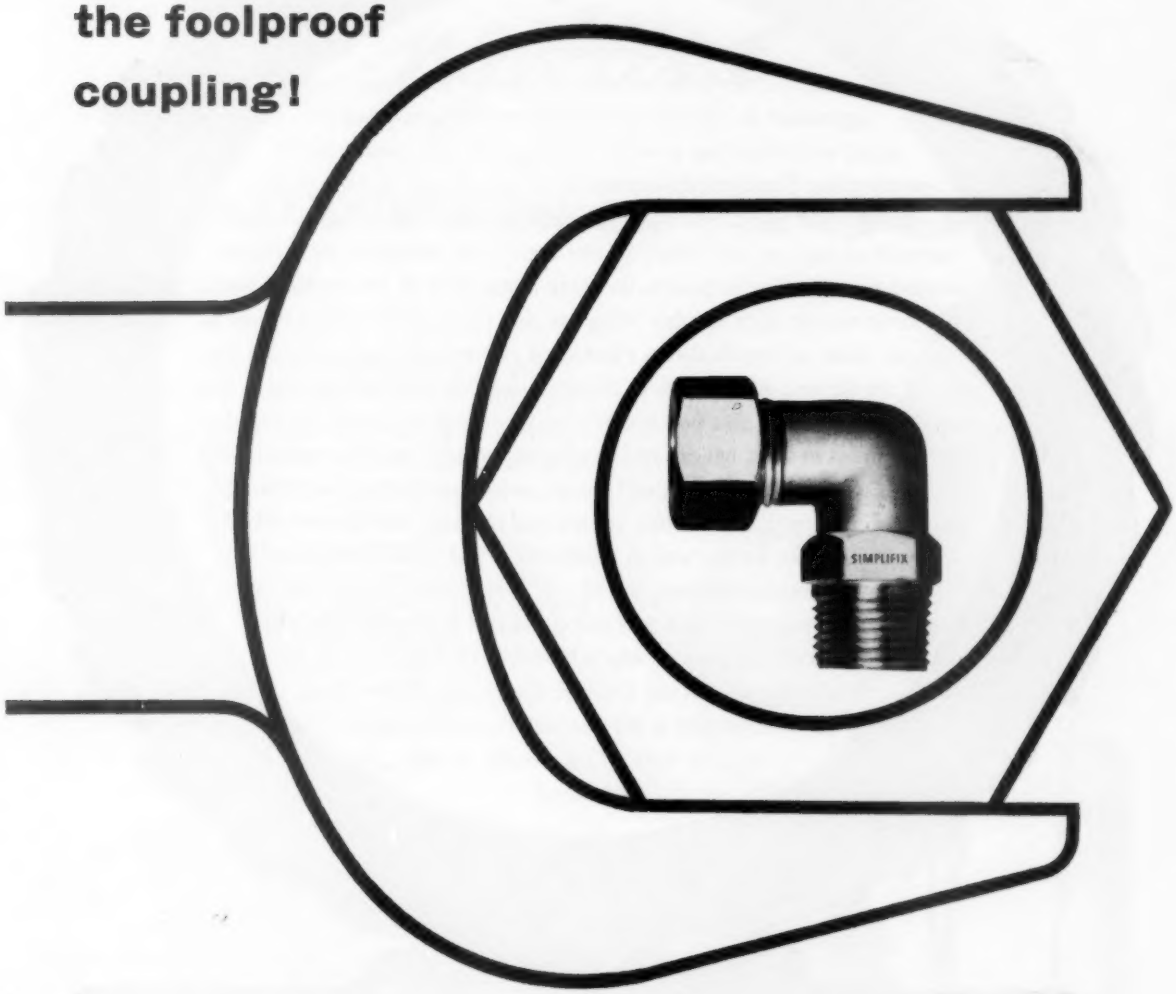

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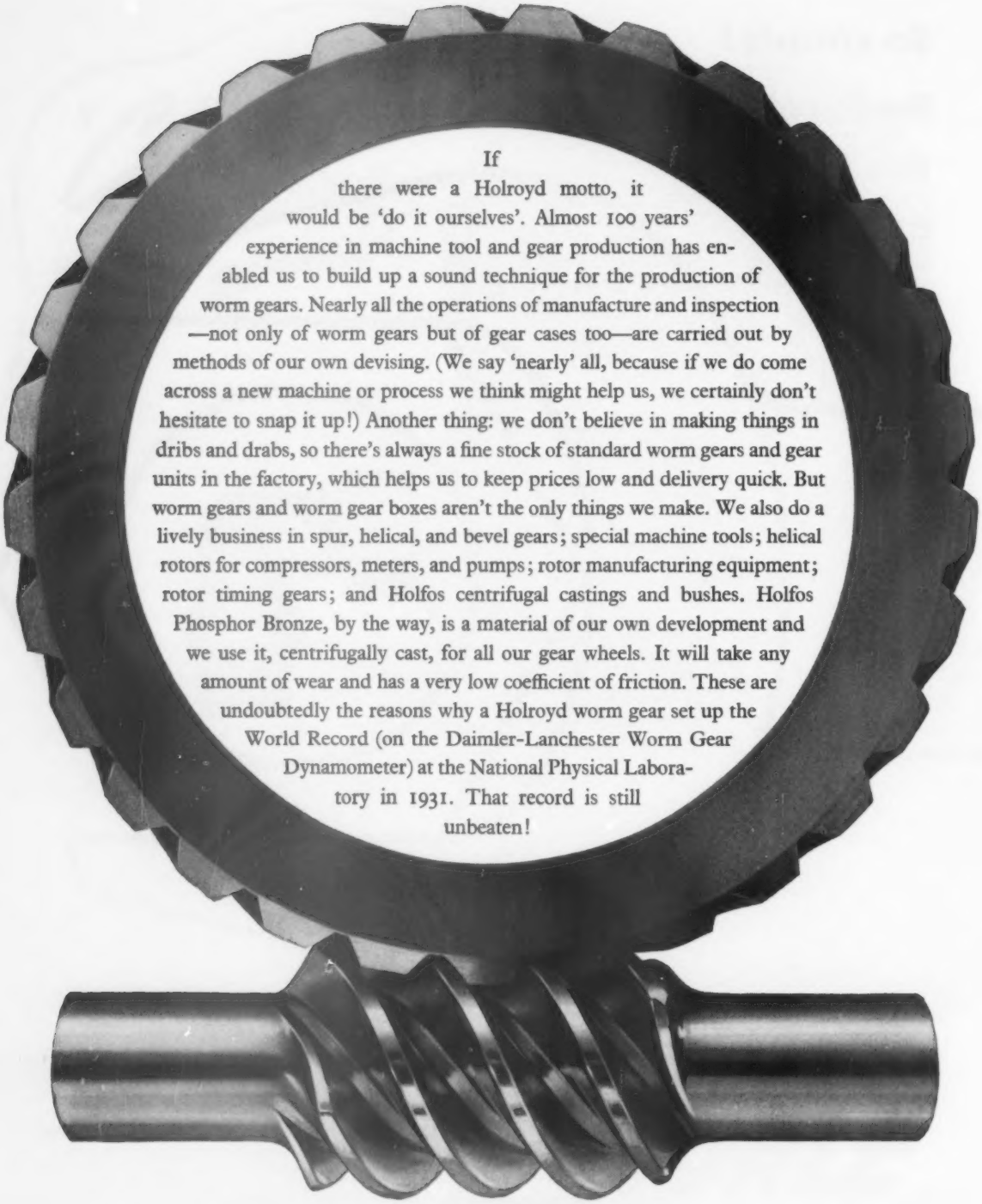

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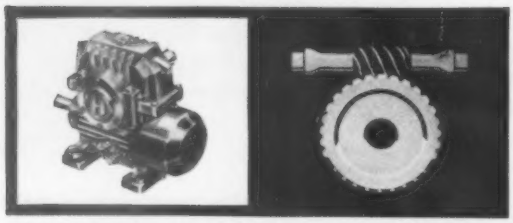

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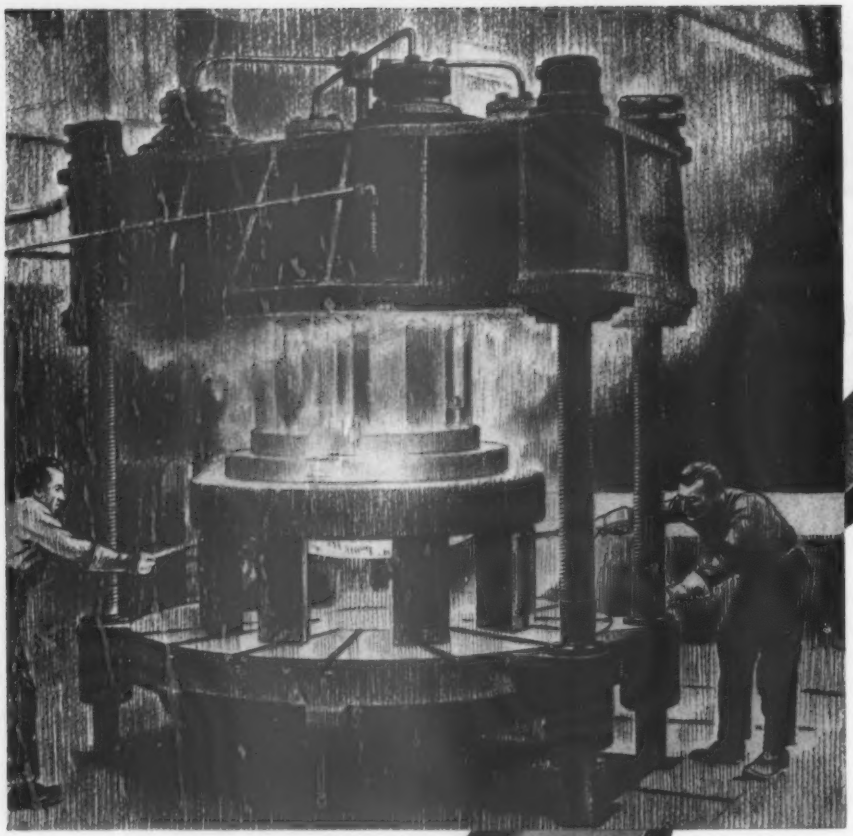

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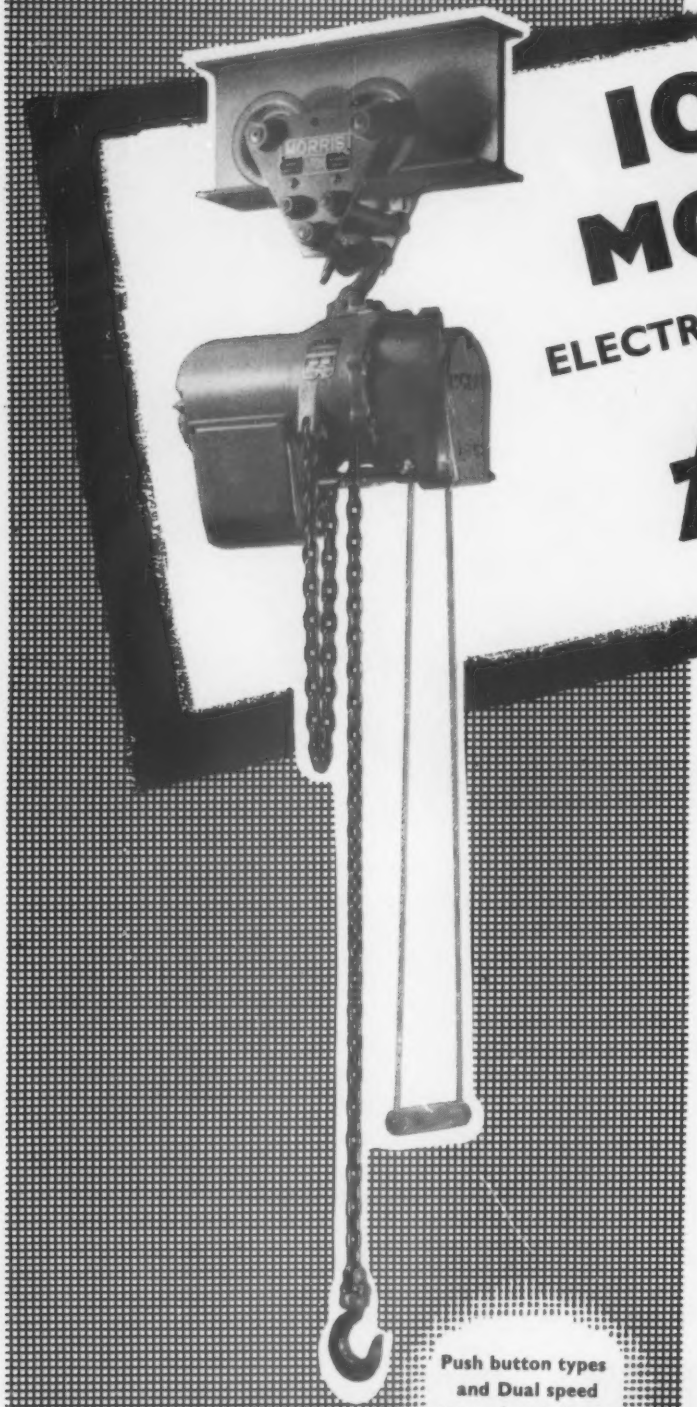

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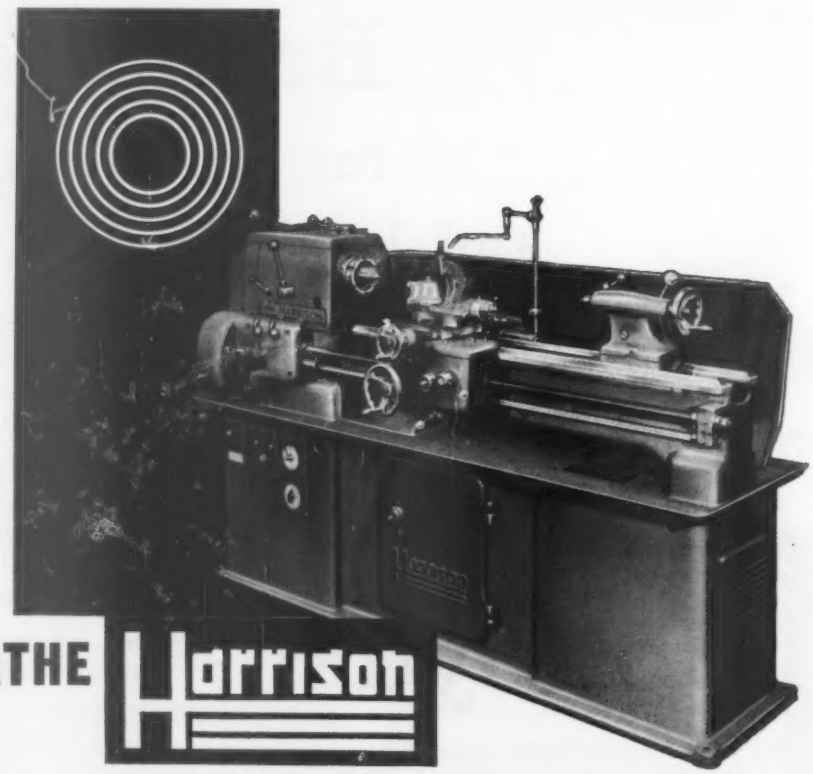

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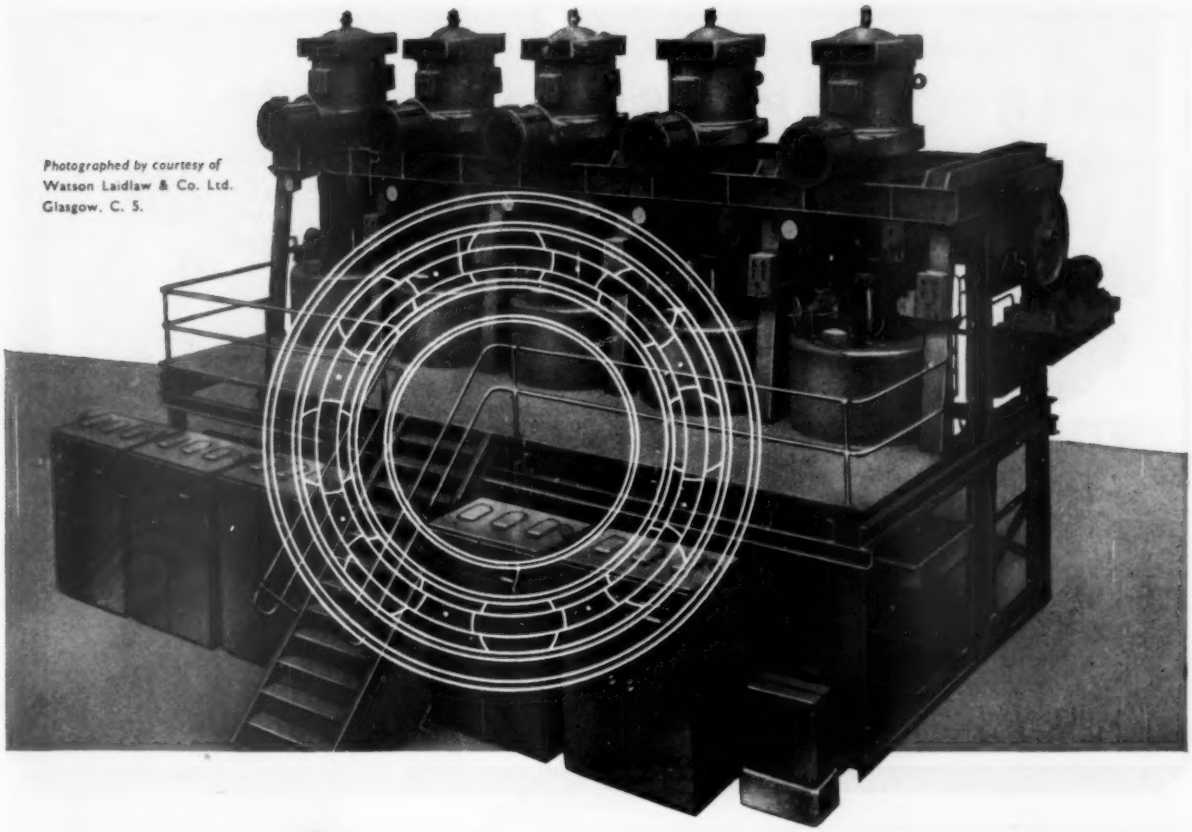

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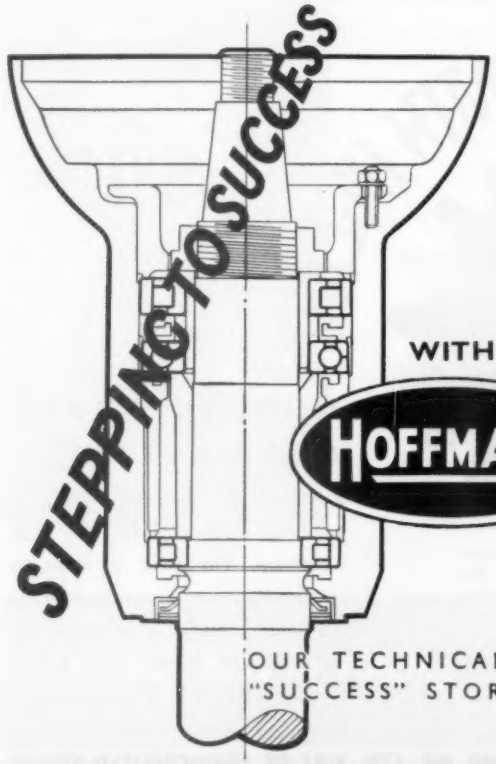

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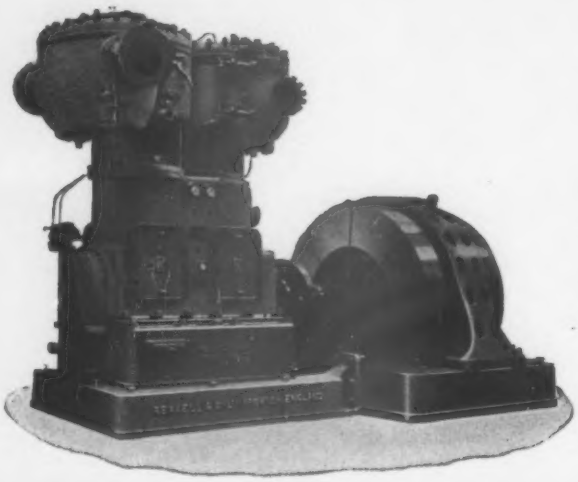

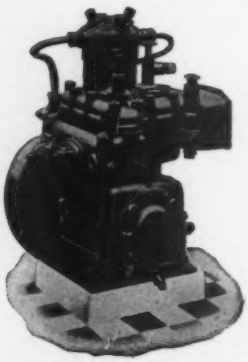

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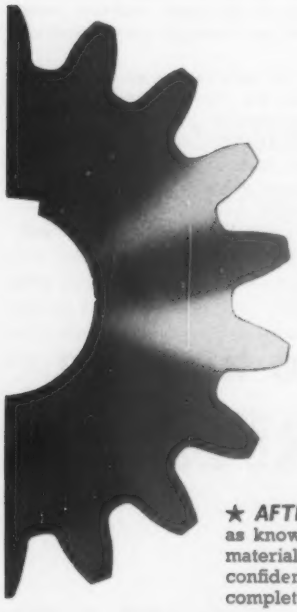

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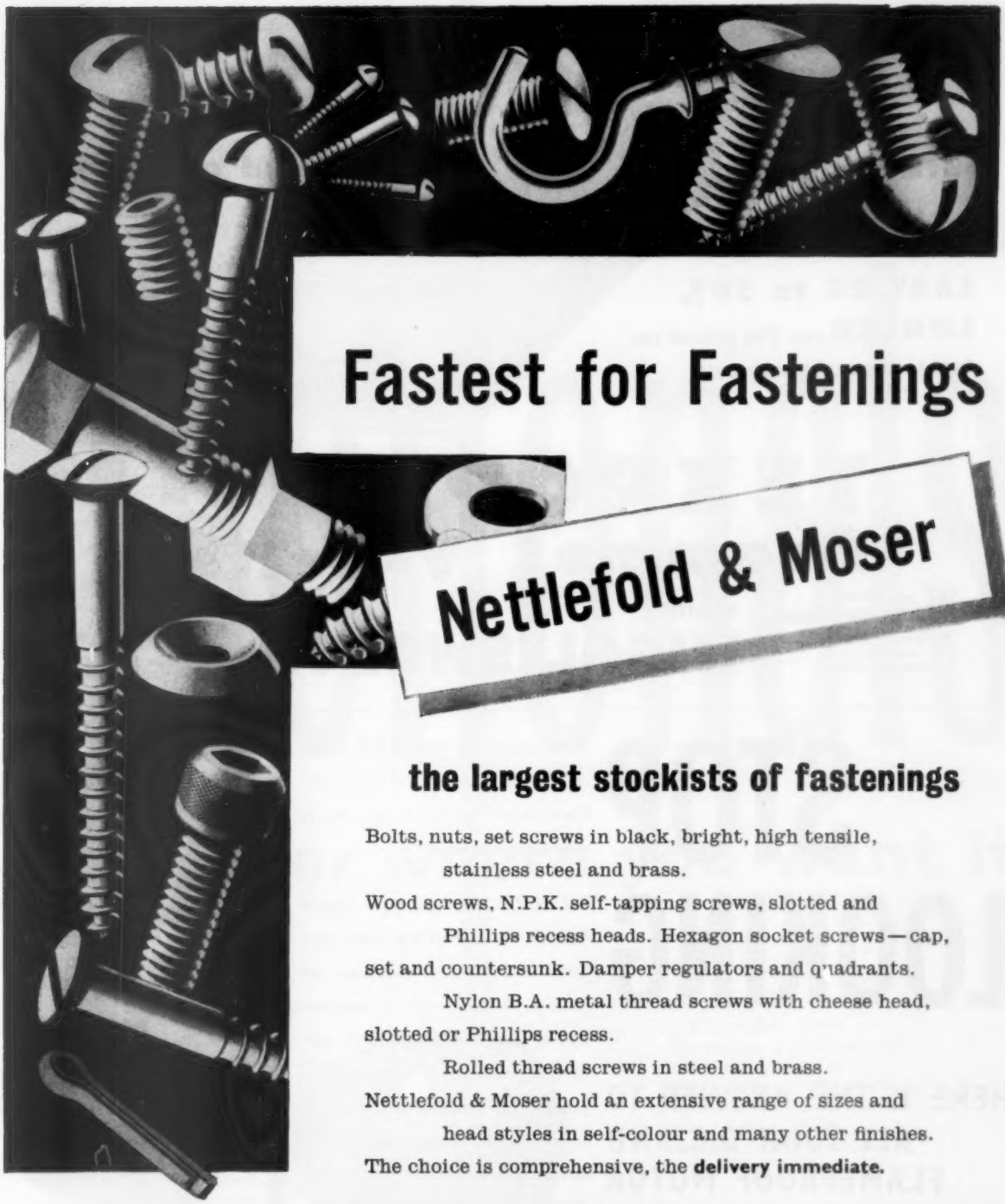

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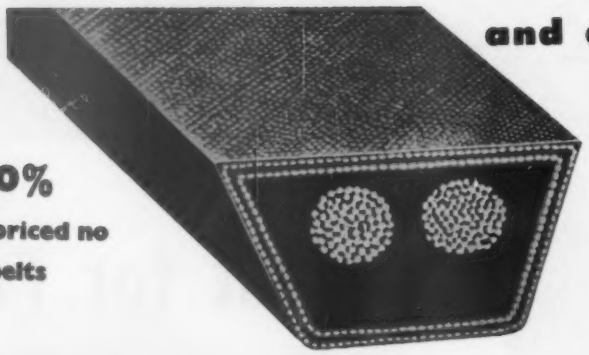
between this  and any other V-belt

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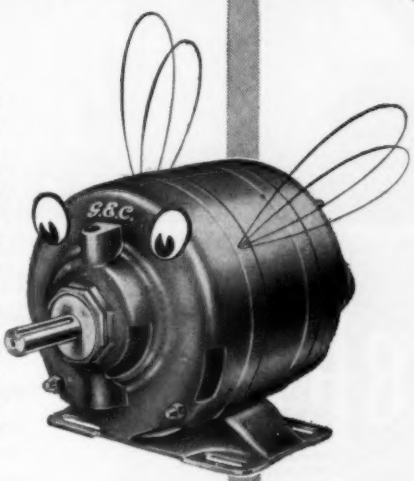

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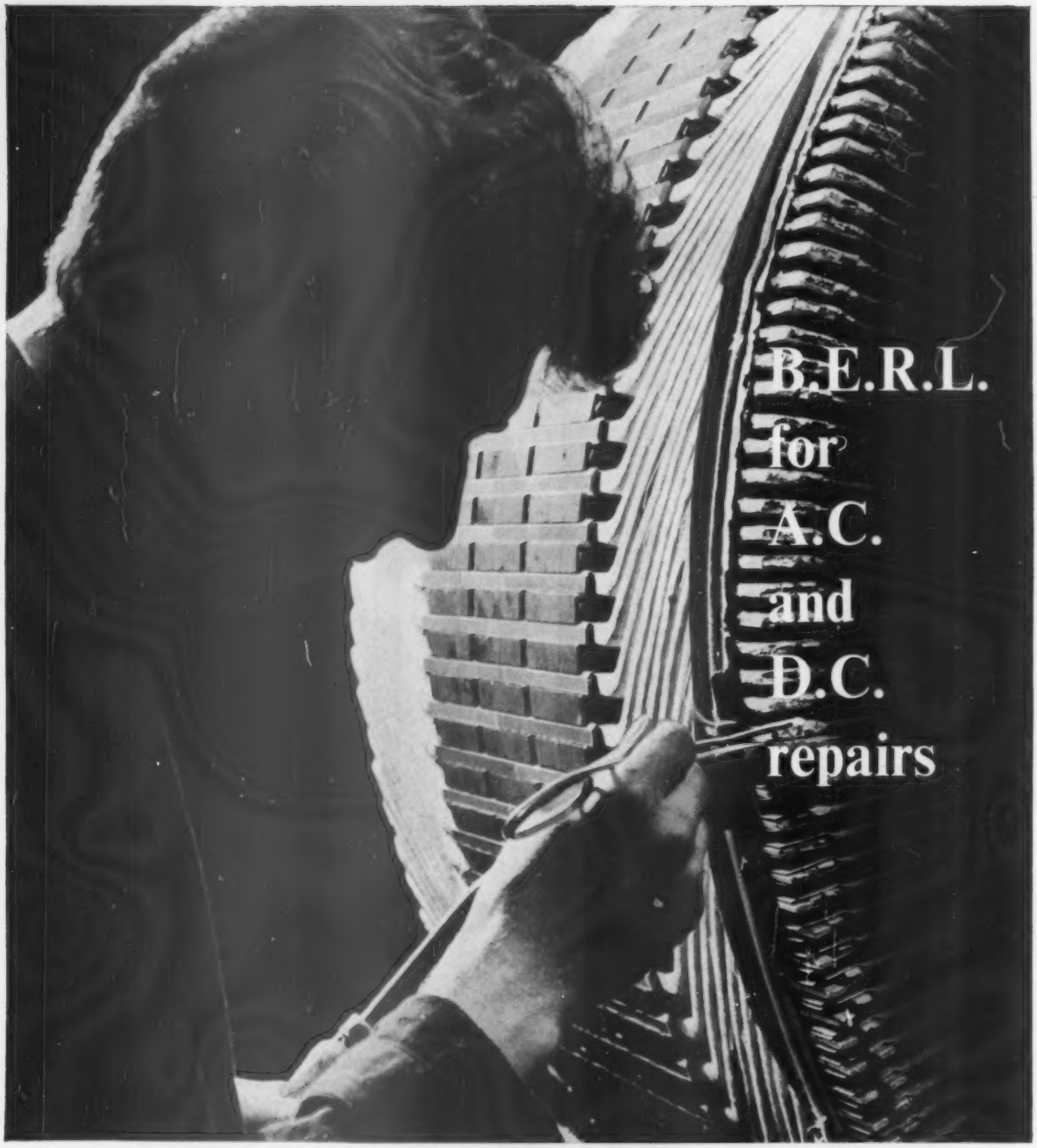

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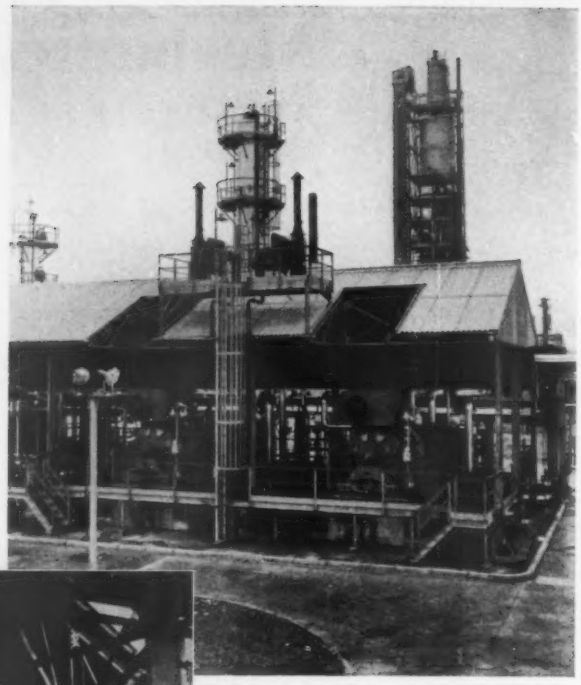
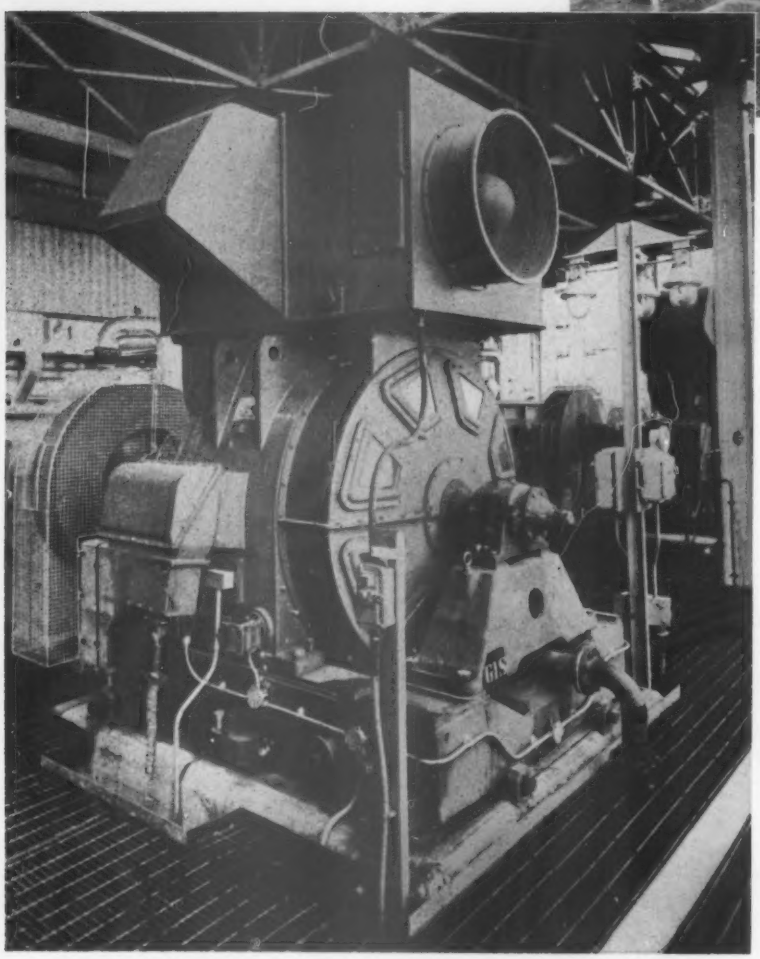
Thousands of L.S.E. motors serve the chemical and allied industries





Two 350/120 h.p., 585/200 r.p.m. N-S variable-speed a.c. motors driving gas compressors at Coryton Oil Refinery. Closed-air-circuit type, pressurized from a source of filtered air. (Photographs reproduced by courtesy of the Mobil Oil Company Ltd.)

LAURENCE, SCOTT & ELECTROMOTORS LTD.

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Technological Simplification

THINGS like computer-controlled machine tools, automatic factories and nuclear reactors require staffs of specialists. They are therefore not things which can be substituted for existing machine tools, ordinary factories and the usual type of power station with no other change than the form of the machinery. It is not likely, even, that existing staff could be trained to work the new devices, for nothing short of completely specialized education and training are needed. The economic aspect of the new style is therefore extended by the necessary inclusion of new staff, and consequently of a new organization.

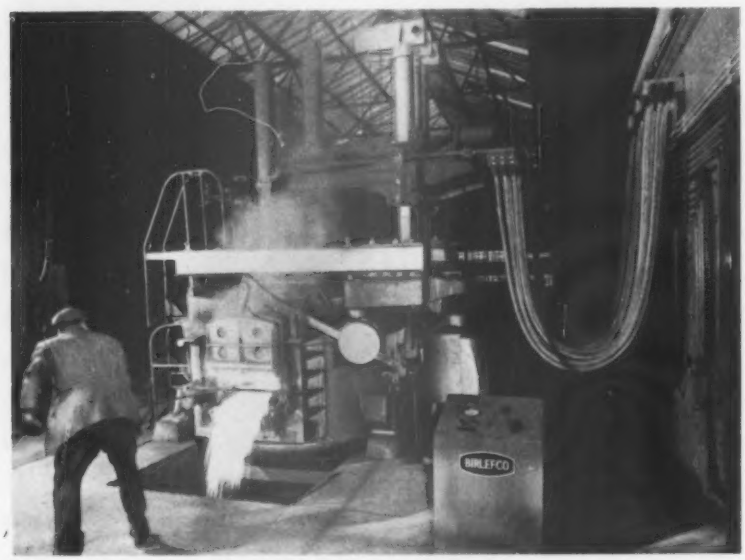
The combination is far from impossible even at present, but it does not suit every case; in fact it suits only a few—those places where computer control can be regarded as a natural attribute, factories where processes are continuous and the scale of operations is very large, and nuclear power stations which at present stem from fully staffed research organizations. Anything less is indeed a problem, and the Joint Panel on Nuclear Marine Propulsion have found it so with atomic energy for ships. In fact, F. Anscomb and F. Hutber in their paper "The Control and Instrumentation of a Marine Reactor", read to the Institute of Marine Engineers on January 26, express the view that the problems associated with the installation of nuclear power in a ship are comparable with those encountered with armament in a modern warship, where the number and diversity of the crew are necessarily very large by comparison with a merchant vessel, to say nothing of the special qualifications required. The provision of such specialized staff makes any but a problematically large vessel seem an uneconomical proposition at present.

That is undoubtedly the picture—but only for the immediate present. Whereas the historical characteristic of technological novelty is complication, the course of technological evolution is always simplification. In time, therefore, all these things will become practicable on a much wider scale. And the time will not be long—the rapid rate of development is sufficient guarantee of that.

LOG SHEET

Pig Iron from Scrap Steel

Pig iron for the wide range of cast-iron products made at the Ferranti Foundry at Hollinwood, Manchester, will now be produced from reclaimed scrap steel. This has been made possible by the installation of a new Birlefco 3-ton capacity electric-arc furnace. Although electric-arc furnaces used for the production of steel from scrap metal are quite common today, the production of pig iron from reclaimed scrap steel is a departure from normal practice. Ferranti Limited believe that they are the first heavy electrical engineering company in Britain to put such a scheme into operation.



Slagging-off operation being carried out on the new Birlefco 3 ton capacity 1600 kVA electric-arc furnace installed in the Foundry of Ferranti Limited, at Hollinwood, Lancs

The scrap consists basically of croppings from transformer laminations and other mild steel. To this, back scrap from the foundry together with a recarburizing compound will be added. This will take the carbon from the low figure of about 2% up to the desired 3–3½% and the steel will become cast-iron on the addition of silicon and manganese, the actual amounts depending on the grade of cast-iron to be produced.

One of the other materials to be produced in the new furnace will be the company's NOMAG, a non-magnetic grey cast-iron which was developed by the Foundry Department in 1923. This has a high specific resistance and has proved of great value to the electrical industries for the manufacture of resistance grids. Because of its non-magnetic properties it is widely used for stator end plates. It has a high nickel and manganese content and is an austenitic cast-iron with reasonably high strength.

Spheroidal graphite iron possessing the equivalent strength of mild steel, will also be produced, and also NOduMAG which is basically NOMAG with spheroidal graphite. The department also produces a high strength flake graphite cast-iron with tensile strength in the region of 17–18 ton per sq in.

The roof of the furnace can be slewed hydraulically, enabling charging to be carried out very quickly using a bucket. Temperature can be closely controlled, and close control of the composition of the metal is carried out with a Strohlein apparatus which can determine simultaneously the carbon and sulphur content of a sample obtained from the furnace within five minutes.

Immediately after S.G. iron is treated with magnesium alloy a sample is taken, polished and examined under a microscope to determine that the graphite is in spheroidal form, and is then checked on the Fuess spectroscope for residual magnesium content.

The furnace consists of a cylindrical, refractory-lined, bowl-shaped shell 7 ft dia with three triangularly spaced electrodes projecting vertically through the removable roof and connected through flexible cables to a furnace transformer. The roof ring in which the roof refractories are seated is water cooled, as are the electrode arms and clamps in which the 8 in. dia by 6 ft long electrodes are held.

Electro-mechanical winch motors, wire rope and counterbalance are provided for each electrode and control is by an Amplidyne regulator which maintains a constant arc and a high average power input.

Precision Tools

After 50 years of continuous development Moore & Wright (Sheffield) Limited have moved into a modern, 156,000 sq ft factory on a 12-acre site at Handsworth Road, Sheffield 13. The company is internationally known for the manufacture of precision and hand tools, and, in particular, micrometers.

The business was founded in 1906 by the late Mr. Frank Moore and has grown from a one-room workshop to the large concern it is today. The manufacture of micrometers to precision limits using quantity production methods was commenced in 1924 and during the Second World War nearly 20,000 per month were produced.

In 1945 John Shaw & Sons, Wolverhampton Limited, an old-established firm who celebrated their 150th anniversary that year, acquired Moore & Wright. Among other subsidiaries are Jenks Brothers Limited and The British Tool & Engineering Company Limited who manufacture and sell the Britool range of engineers' hand tools which includes socket sets, wrenches and interchangeable parts and specialized service tools.

Although Moore & Wright are mainly known throughout the world for the manufacture of micrometers, other precision tools manufactured include engineers' try squares, combination sets, bevels, surface gauges, bevel protractors, die makers' squares, gauges (depth, feeler, radius, screwpitch, telescopic, small hole) and engineers' straight edges. Hand tools include callipers, dividers,

General view in the main shop at the new Moore & Wright tool factory

chisels, blowlamps, scribers, engineers' scrapers, ratchet and spiral ratchet screwdrivers, and box spanners. A feature of Moore & Wright precision instruments is the matt chrome finish given to the graduation to eliminate glare and ensure easy reading in all conditions.

Continuous Lamp Manufacture

A new machine for making the pinch seal of an incandescent lamp, the basic stage in manufacture, has been developed by the Osram Lamp Works of The General Electric Company Limited. The machine has recently been undergoing production trials at a speed of 3500 pinches per hour, and is probably the fastest machine in the world for performing this type of operation. It is capable of greater speeds still. The machine uses a new principle in lamp manufacture—the constant and uniform flow of the lamp through the processes instead of step by step production.

A 'pinch seal' contains four parts. These are a flanged glass tube, a hollow glass stem which is now both an exhaust tube and filament support, and two lead wires with fuses. The filament of the lamp is subsequently mounted on to the assembly and finally sealed into the lamp bulb.

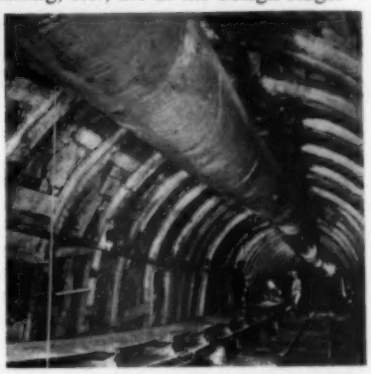
So far, pinch seals have been manufactured by using a turn-table or turret. This moves round so that each station on it comes to rest in succession at a given fixed position. Feeding devices, manipulating tools and heating burners are arranged at these positions. A pinch seal assembly therefore moves from one rest position to another round the machine, going through a succession of operations until completed. By using this system, a number of parts can be processed at the same time and several operations can be performed on one machine.

Modern machines of this type can handle about 1500 to 1800 parts per hour but they have limitations which make increases of speed difficult. Stopping and starting more frequently requires greater acceleration forces, which stress the machine more highly and make maintenance necessary at shorter intervals. Speeding up the machine reduces the length of the rest periods during which the operations are carried out. If these involve heating or cooling there may not be enough time in one rest period to complete the process and more stations may have to be arranged on the turret to allow for this. This means a larger diameter turret and therefore greater stresses in the machine.

The new Osram machine revolves steadily and continuously instead of repeatedly stopping and starting. It cuts out the strains of repeated acceleration and deceleration, the whole time of one revolution can be used for processing and more than one operation can be carried out on the lamp simultaneously.

The machine has a rotating turret with forty work heads, each complete with its set of tools and burners. Five devices round the turret feed the components to the work heads and the completed pinch seal is removed by a small transfer turret. Feeding and take-off are both accomplished without any jerkiness.

The new principle can be applied at much greater speeds than are being used at present, speeds which are quite impossible for conventional machines. The machine itself is only the first step in achieving a complete manufacturing group based on the constant flow principle. Other machines using this principle for the subsequent operations such as filament, mounting, sealing-in, gas-filling, etc., are at the design stage.



Terylene ventilation ducting at Parsonage Colliery, Leigh, one of the deepest mines in the country. The N.C.B. has now placed a bulk order for over 30 miles of this ducting

Terylene for Air Ducts

Ventilation ducting has an all-important role to play in the day-to-day running of a coal mine. For some time now, various materials have been used in British mines for ventilation ducting including p.v.c.-coated jute, rayon and cotton fabrics. Not long ago a bulk order for more than 30 miles of p.v.c.-coated 'Terylene' ventilation ducting (fire-resistant in accordance with N.C.B. requirements) was placed, varying in diameter from 12 in. to 24 in. and stitched throughout with Terylene thread.

Made up by Robert Watson & Co. Limited, Newburgh, Fife, from a specially woven 2½ oz per sq yd twistless Terylene base fabric the ducting is about three times lighter than that formerly used. Its use results in easier handling, greater efficiency and longer life.

The lightness of the coated Terylene fabric has found particular favour among the miners themselves, while its very high rot resistance and

retention of tear strength are marked advantages where damp conditions prevail.

Death of "Rock'n Roll" Line

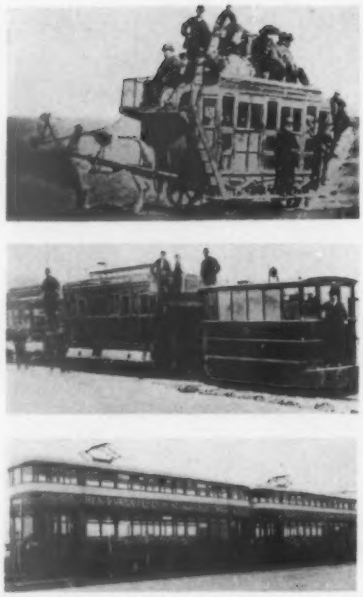
During its 155 years of life the world-famous Swansea to Oystermouth Railway has used no less than seven forms of motive power—horse, air, steam locomotive, battery railcar, petrol locomotive, diesel locomotive and overhead electric traction. The old railway is no longer an economic proposition and everything it owns, except a pier and a luxury hotel at the end of it, are being demolished by Thos. W. Ward Limited, of Sheffield. Even the quaint old passenger bridge which spans the line from the main road to the beach is to go.

In 1899 the Swansea Improvement & Tramways Company (forerunner of S.W.T.) signed a lease with the Swansea & Mumbles Railway Company, and the Mumbles Railway & Pier Company to take over the railway and pier undertakings of the two latter companies for a period of 999 years at an annual rental of £13,900. When the official decision to scrap the line was made some months ago, that old agreement still had some 939 years to run—with an ultimate commitment that would have eventually cost more than £13,000,000 in rent alone.

It was while considering the problems involved that the opportunity arose to buy the shares of the Mumbles Railway and Pier Company and the Swansea and Mumbles Railway Company for £200,000, representing approximately fourteen years' rental. The whole question was again examined in the light of this new circumstance, and it was decided that the railway must go. Powers were therefore sought to bring about its closure and even the Swansea Corporation who, under Act of Parliament, had a say in the matter, agreed that the old railway had long ago outlived its useful life. The only real sadness will be among those people to whom the familiar jolting old red coloured cars, the quaint little wayside stations and the uneven rails had become a part of the daily scene.

Photo-optical Memory

Photographic plates used in the permanent memory of an experimental electronic telephone switching system are now being exposed and developed automatically, according to Bell Telephone Laboratories. The permanent memory stores such things as directory information and instructions for the electronic switching system. This information is in the form of thousands of tiny clear dots on an otherwise opaque photographic area 2 in. square. Seventeen areas are used together to make up a complete photographic plate, and the entire permanent memory store is comprised of four such plates.



Three stages in the history of the Mumbles and Oystermouth Railway which is now being dismantled by Thos. W. Ward Limited. At top, the horse-drawn train of 1865. At centre, the steam locomotive and train of 1877. At bottom, the present day electric train

The spots of clear and opaque film are scanned by a beam which is generated by a cathode ray tube and focused by a system of lenses. This operation gives rise to the name of the unit—"Flying Spot Store". The movement of the beam is controlled by an electronic and optical positioning system, which must be accurate enough to pick out on each area a particular spot location.

The flying spot store contains over two million bits of information as opaque or transparent spots, and can read out a 68 bit word (i.e., 68 spots simultaneously) every two and a half microsends. Random access to any word adds a major feature of versatility.

The store itself is used to expose the plates. The moving beam from the cathode ray tube is focused through an objective lens on to the photosensitive area. The spot is moved over the entire two inch square image area and stopped briefly at positions where a spot exposure is desired. A photographic emulsion was selected which is "slow" enough not to be exposed by the passing of the beam alone, but requiring the lengthened exposure of the pause to make a record.

Each of the seventeen small areas on a plate is exposed individually, in sequence, while the others are covered by a system of shutters. Automatic control of this operation allows an entire plate, containing 550,000 spot positions, to be exposed in less than three minutes.

After exposure, the plates are withdrawn from the memory unit in a dust- and light-proof container and inserted into the automatic processor for developing and fixing. Two of the plates can be processed simultaneously.

Once the plates are inserted in the processor, they are automatically carried through a number of steps. They are dipped into one tank after another, depending on a predetermined schedule. As many as fifteen steps may be involved in a typical reversal processing schedule, and appropriate dwell times are also set to allow proper processing.

After developing, reversal, and fixing operations have been completed, the plates are rinsed and dried in filtered air, and delivered back into their container for reinsertion into the memory unit.

The time required for a complete developing schedule is less than a half hour. Once the machine has been put in operation, it will continue through its sequence without interruption. The machine has been made simple to operate since it is expected that personnel unfamiliar with photographic procedures will operate it.

Storing Gas Underground

At Haverton Hill on the north bank of the River Tees, the Northern Gas Board is using a large cavity in the underground stratum of salt to store 10,000,000 cu ft of gas at 30 atmospheres pressure. How this is done and the details of the project were described by Mr. E. Crowther, chairman of the Northern Gas Board, in a paper presented to the Institution of Gas Engineers on November 18.

The cavity is roughly pear shaped and occupies nearly the full depth of the 115 ft layer of salt, the top of which is 1176 ft below ground level. It was made specially for the board by Imperial Chemical Industries Limited whose Billingham plant is near by, the method used being washing out the salt with water so that it comes to the surface as brine.

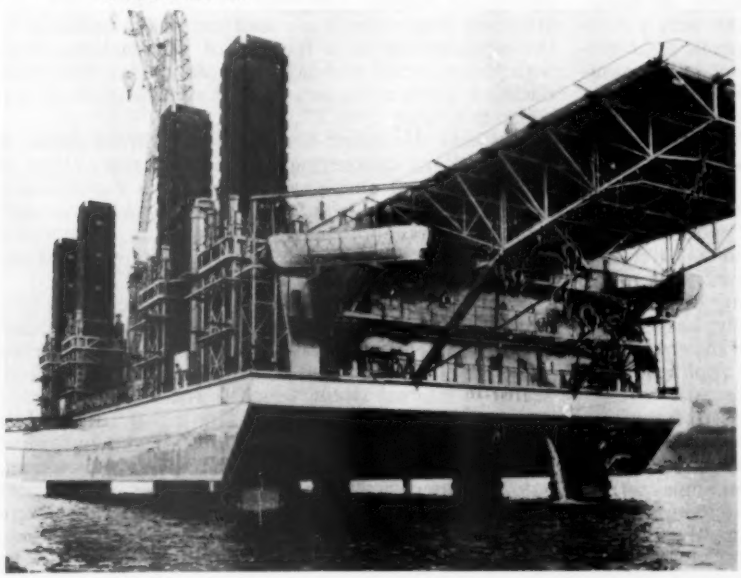
When the cavity was handed over to the board it was full of brine and this was displaced through the brine pipe, which reaches nearly to the bottom of the cavity, when the gas was pumped in through the annulus between the brine pipe and the larger casing pipe. During the operation 338,000 cu ft of brine was expelled.

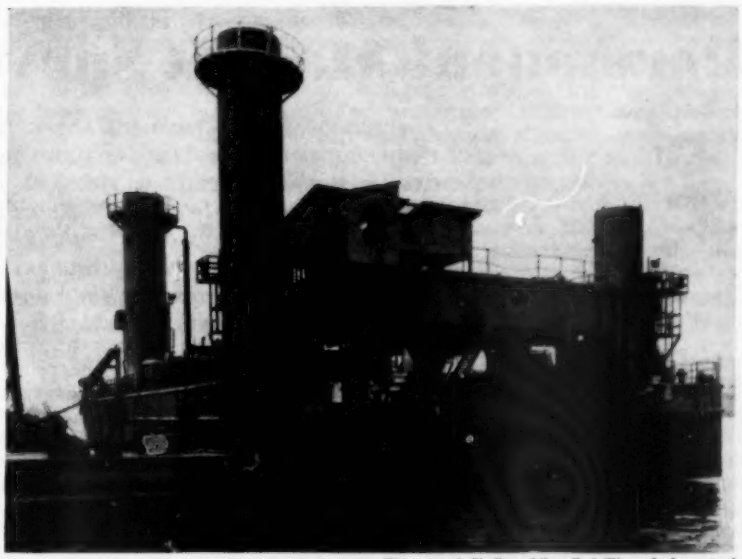
The gas compressing set installed on the surface comprises two Peter Brotherhood machines each designed to raise 1030 cu ft per min of free gas to a maximum pressure of 30 atmospheres.

New Mobile Oil Rigs

The Seashell, the £1,800,000 mobile oil-drilling platform built for Shell as a more versatile successor to the one wrecked in a sudden storm three years ago off Qatar, in the Persian Gulf, is now in commission in Doha Bay, Qatar. Two Dutch tugs towed the Seashell 6400 miles to Doha Bay from Schiedam, Holland, where it was built.

The mobile oil-drilling platform, the "Sea-Shell" in Doha Bay, Qatar, where she will drill under-water exploration wells. Her eight legs can be lowered to the sea bed as shown here, and the pontoon hull raised 30 ft above water level





The second Shell mobile oil drilling platform to be constructed in the United Kingdom

The Seashell consists of a pontoon 209 ft long, 105 ft wide, and 17 ft deep, with eight legs 218 ft long and 10 ft square. It has been designed to withstand gales of up to 100 mph and waves 30 ft high, while working in water 100 ft deep. The pontoon hull carries machinery suitable for drilling to depths of 17,000 ft and ancillary servicing equipment, including a 75-ton completely mobile portal crane. The Seashell has a detachable helicopter deck which projects over the water and can be folded away before making long tows.

A further mobile oil drilling platform, the second to be constructed in the United Kingdom, has been built at Wallsend-on-Tyne. Built for Shell by Clelands Shipbuilding Company, the "Triton" as she is called, was designed by Shell's Dutch associates, Bataafse Internationale Petroleum Mij., in conjunction with De Long Limited who, as main contractors, have been responsible for engineering and supervision of construction.

The "Triton", which has cost over half a million pounds and contains 1500 tons of steel, has been built for operations in water depths up to 120 ft and is fitted with four retractable legs, each of 200 ft in length and 8 ft dia.

Hydraulic mechanism will be used to raise the entire platform, at a speed of 30 ft per hr, clear of the water and any lifting action from waves. As drilling is finished the legs can be raised and the platform can be towed to another location. Living accommodation on board has not been provided for, as drilling crews will be ferried to and from shore bases.

The "Triton" is designed to withstand waves of 8 ft height from trough to crest and a wind velocity of 75 mph under operating conditions.

The hydraulic cylinders for raising and lowering the legs are powered by pumps driven through 60 hp electric motors drawing current from four alternators each of 136 kW rating. The platform is 115 ft long, 80 ft wide and 15 ft deep.

Permanent Magnet Survey

The numbers of permanent magnets produced and used annually is truly enormous—unobtrusively serving every field of industry, commerce and even the domestic world. The scope of permanent magnets has increased enormously during the past twenty years, with the introduction of high-energy alloys on a commercial basis. This article surveys in a comprehensive manner permanent magnet materials, design and selection and includes working data on some two hundred different alloys, ferrites and micropowders.

PRACTICAL application of permanent magnets in the form of the supposed supernatural lodestone, probably dates back some four thousand years. Traditionally the Chinese are credited with the invention of the compass for navigation purposes in the form of the "South-Pointing Chariot", the secret of which was lost and, indeed, the principle of which has subsequently been challenged (some authorities now hold that the "South-Pointing Chariot" was a mechanical device operating with a differential gearing system to indicate a change in course).

In point of fact the first authenticated case of the use of a compass in China is rather less than a century in advance of its appearance in Europe, and the two appear to be independent discoveries. The original compasses were very primitive affairs, consisting of an ordinary needle pushed through a piece of straw and floated on water, the needle being magnetized by application of a lodestone. Not until the latter part of the seventeenth century did the compass achieve any marked degree of reliability and right through until the end of the nineteenth century compass design varied considerably, although the basic principle of employing a permanent magnet element remained unchanged for all forms of compasses until the appearance of the gyro compass as an alternative. Of more recent years the inductor type of magnetic compass has come to the fore.

Meantime, of course, other applications of ferromagnetism had been developed and many were put to practical use. The discovery of electromagnetic principles and the development of the electromagnet in the nineteenth century represented a temporary eclipse of the permanent magnet for industrial use—but this was only a temporary effect. Due largely to the considerable technical developments in permanent magnet materials during the last quarter of a century, the permanent magnet has invaded almost every aspect of industry and commerce as a simple, practical working unit, incorporated unobtrusively in apparatus in everyday use. Production is so vast that in this country alone the turn-out of individual magnets is currently of the order of one per head of the population annually. Largely this has been due to the outstanding growth of the electronics industry, although the purely mechanical applications of permanent magnets have continued to expand.

From the original lodestone and magnetized fragments of nickel-iron alloys found in meteorites, the very early permanent magnets were made from carburized steel—differing widely in their property of retaining magnetism because of the considerable variation in composition resulting from the rudimentary iron smelting of the time. By the latter part of the nineteenth century, however, the principle permanent magnet material in use was a glass hard carbon steel with a carbon content of the order of 1·5%. It suffered from the limitation of being susceptible to mechanical shock and temperature variation and needed to be of generous size for satisfactory performance.

Various tungsten steels were known, and in use, by the beginning of the present century, offering enhanced performance, albeit at higher cost. A considerable impetus to their use and development was given by the invention of the internal combustion engine and the evolution of high tension magnetos to provide ignition, for which application it became a standard material.

Cut off from tungsten supplies by the blockade during World War I, German scientists developed a 6% chromium steel as a substitute which, although somewhat inferior in performance, had the advantage of being cheaper to produce. Hence chromium steel remained as a commercial alternative for "strong" permanent magnets after the war on account of the price factor.

At a similar period—just after the end of World War I—two Japanese metallurgists developed a 35% cobalt steel as an outstanding permanent magnet material, with a considerably higher coercive force than the tungsten and chromium steels and an appreciably higher BH_{max} value. This, again, has continued with little modification from the original composition as a standard permanent magnet material. At the same time, the attractive properties of a cobalt steel alloy gave rise to the development of a number of intermediate alloys with lower cobalt and higher chromium content, producing a whole series of standard materials with cobalt contents ranging from 3% to 35%.

The next significant step again came from Japan in 1931, Mishima discovering that certain ternary alloys of nickel, iron and aluminium exhibited an exceptionally high coercive force, from which was established an alloy exhibiting optimum magnetic properties, comprising approximately 29% nickel, 12·5% aluminium and the balance iron. This became known as "Alni".

Alni introduced a new class of permanent magnetic materials which were not steel at all (having no significant carbon content) but essentially dispersion-hardening alloys. By this is implied that the material has a high degree of internal strain, which is associated with good permanent magnet properties. The higher the internal strain the more difficult it is to turn the individual particles of the material or "domains" into alignment, but the more difficult it is to turn them out of alignment once they have been magnetized. At the same time there are mechanical disadvantages. Dispersion-hardening alloys are invariably brittle and extremely hard. The

extent to which they are affected by annealing is negligible and working is virtually limited to grinding. Hence such magnets are produced by casting to the final form required, or sintered from powder forms of the alloy (with some loss of properties due to the lower density of the sintered product).

The dispersion-hardening alloys are subjected to two stages of heat treatment, known as hardening and tempering, although these are essentially referring to metallurgical rather than mechanical characteristics. The heat treatment required to give best magnetic properties may differ considerably from the heat treatment required on the same alloy to produce maximum mechanical hardness. Hence evaluation of mechanical hardness is no criterion as to the permanent magnet properties of the material.

A second type of dispersion-hardening alloy was evolved in 1934 by Horsburgh and Tetley in Sheffield, by the addition of cobalt to the ternary nickel-iron-aluminium system. Optimum composition was established as 18% nickel, 12% cobalt and 10% aluminium, the balance being iron, this alloy being known as "Alnico".

In 1938, further experiments on Alnico by Oliver and Shedden showed that if the material was cooled from the hardening temperature in a magnetic field, superior magnetic properties could be produced in one direction at the expense of all other directions. Essentially, the presence of the magnetizing field orientated the domains when the alloy reached the Curie point (and still at a high enough temperature to be plastic), subsequently freezing in that alignment. The orientation along a preferred axis is then permanent, regardless of how many times the alloy may subsequently be magnetized and demagnetized. Such magnet materials are referred to as anisotropic. The anisotropic aluminium-nickel-cobalt dispersion-hardening alloy was given the name Alcomax in this country, Alnico-V in America and Ticonal in Holland (see later for comments on names).

Further improvements with the Alcomax alloy were realized by the British Permanent Magnet Association by introducing niobium (i.e. columbium) into the alloy, resulting in Alcomax-III and Alcomax-IV (1948). Of these, Alcomax-III exhibits the highest energy content, and Alcomax-IV the highest combination of energy and coercive force of the dispersion-hardening alloys developed to date.

More recent work with similar materials has concentrated on the production of columnar crystal magnets, where an increase in performance of up to 100% is possible. In an ordinary cast magnet the crystal growth is similar to that in any ingot, with the crystals growing inwards from the cooling surfaces and with random alignment in the centre. Columnar alignment can be produced by maintaining high, controlled heat on the sides of the magnet during cooling and chilling other regions of the shape to encourage crystal growth from the pole faces—a difficult technique to ally to production methods. Alcomax-IV S.C. magnets currently produced are semi-columnar and can only effectively be produced in limited shapes and sizes. Individual columnar alignment permanent magnets have, however, been

Table I—MAGNETIC PROPERTIES OF STANDARD (BRITISH) PERMANENT MAGNET MATERIALS

Type	Material	Remanence B_r Gauss	BH_{max} mega-gauss-oersteds	Coercivity H_c oersteds	B at BH_{max} gauss	H at BH_{max} oersteds
Carbon steel	1% Carbon steel	9,000	0·2	55	—	—
Alloy steel	Chrome steel	9,800	0·235	70	6,200	46
,, ,,	6% tungsten steel	10,500	0·30	65	6,980	43
,, ,,	Cobalt–chromium	9,800	0·32	80	6,275	51
,, ,,	3% cobalt steel	7,200	0·35	130	4,220	83
,, ,,	6% ,, ,,	7,500	0·44	145	4,680	94
,, ,,	9% ,, ,,	7,800	0·50	160	5,000	100
,, ,,	15% ,, ,,	8,200	0·62	180	5,250	118
,, ,,	35% ,, ,,	9,000	0·95	250	5,930	160
Isotropic alloy	Alni—high coercivity	5,000	1·25	680	3,040	411
,, ,,	—normal	5,600	1·25	580	3,480	359
,, ,,	—high remanence	6,200	1·25	480	4,030	310
,, ,,	Alnico—high coercivity	6,600	1·70	620	4,250	400
,, ,,	—normal	7,250	1·70	560	4,700	362
,, ,,	—high remanence	8,000	1·70	500	5,200	327
Anisotropic alloy	Alcomax II	12,400	4·70	585	10,000	470
,, ,,	Alcomax II S.C.	12,800	5·15	600	10,500	490
,, ,,	Alcomax III	12,500	5·10	670	9,750	523
,, ,,	Alcomax III S.C.	13,000	5·80	700	10,350	560
,, ,,	Alcomax IV	11,200	4·30	750	8,030	537
,, ,,	Alcomax IV S.C.	11,700	5·10	780	8,700	585

Table II.—MAGNETIC PROPERTIES OF STANDARD (BRITISH) PERMANENT MAGNETS IN RATIONALIZED M.K.S. UNITS

Material	B_r Webers/ sq. metre	BH_{max} Joules/ cubic m	H_c amperes/ metre	B at BH_{max} Webers/ sq metre	H at BH_{max} amperes/ metre	Saturation J Webers/ sq metre	Average Recoil Permeability
Chromium steel	0·980	2,270	5,570	·620	3,660	1·55	44·00
6% Tungsten steel	1·050	2,380	5,180	·698	3,420	1·65	49·00
2% Co. 4% Cr steel	0·980	2,540	6,360	·628	4,060	1·60	37·70
3% Cobalt steel	0·720	2,780	10,300	·422	6,520	1·25	23·20
6% Cobalt steel	0·750	3,500	11,500	·468	7,480	1·30	22·00
9% Cobalt steel	0·780	3,980	12,700	·500	7,960	1·35	20·70
15% Cobalt steel	0·820	4,930	14,300	·525	9,400	1·40	18·80
35% Cobalt steel	0·900	7,560	19,900	·593	12,700	1·50	15·10
Alni—High Coercivity	0·500	9,950	54,100	·304	32,700	·90	5·03
—Normal	0·560	9,950	46,100	·348	28,600	·95	6·28
—High Permanence	0·620	9,950	38,200	·403	24,700	1·00	6·91
Alnico—High Coercivity... ...	0·650	13,500	49,300	·425	31,800	1·10	6·53
—Normal	0·725	13,500	44,600	·470	28,800	1·15	7·54
—High Permanence ...	0·800	13,500	39,800	·520	26,000	1·20	8·80
Alcomax II	1·240	35,800	45,700	·99	36,200	1·40	3·77
Alcomax III	1·250	39,800	53,300	·97	41,000	1·40	4·40
Alcomax IV	1·120	34,200	59,600	·80	42,700	1·35	5·03
Columax	—	—	—	—	—	1·40	—
Sintered Alnico (normal)... ...	0·650	11,900	42,200	·470	25,500	—	—
,, Alcomax II	1·070	27,000	43,700	·850	31,800	—	—
,, Alcomax III	1·080	32,600	47,700	·855	38,200	—	—
,, Alcomax IV	0·900	27,800	55,700	·675	41,300	—	—

produced in the laboratory with BH_{max} values as high as 8 to 10 mega-gauss-oersteds, and the fully columnar version of Alcomax, is designated Columax-X.

Within recent years non-metallic oxide permanent magnets have come to the fore, descendents of the original lodestone but applied to modern design requirements, particularly for television focussing magnets and holding magnets. They have become generally known as magnetic ceramics or ceramic magnets, although as classified by the Permanent Magnet Association they are called Feroba—see Table III. Feroba is based on barium ferrite and is produced in both isotropic and anisotropic versions. A particular advantage is a very high coercive force which allows a short dimensional ratio to be employed, although the temperature coefficient of magnetization is some ten times higher than that for alloy magnets. Energy content is about the same as 35% cobalt steel.

During the last six years or so magnesium-manganese ferrites have also been produced with rectangular hysteresis loops. The two types most commonly employed are manganese-magnesium ferrite and copper-manganese ferrite, both cubic spinels. Coercive force is of the order of 1 to 1·5 oersted. The addition of zinc ferrite reduces the coercive force which can, if required, be rendered as low as 0·2 oersted. A main application has been for small toroidal cores in high speed computers.

Other developments in magnetic ceramics include the perovskites—ferromagnetic compounds containing manganese, lanthium and strontium, but not iron. These are being developed to utilize the non-linear characteristics of ferrites "tailored" to specific applications.

A separate class of "powdered" materials are iron micropowder magnets. Essentially these comprise powdered iron materials where the individual particles are no larger than a single domain, the main difficulty being the actual production of microparticles with a length about ten times the diameter and correctly aligned. An interesting feature here is that such materials are largely strain-free, as opposed to the high-strain condition normally associated with good permanent magnet materials. However, the performance of micropowder magnets, both magnetic and mechanical, is low compared with cast magnets of similar volume.

Magnet material names

The carbide-containing steels are defined by significant composition—e.g. 1% carbon, 6% chromium, 15% cobalt, etc., and few, if any, proprietary names survive. Rationalization of the strain-hardening alloys has been undertaken by the British Permanent Magnet Association under the series Alni, Alnico, Alcomax and Columax (columnar aligned Alcomax). However, as noted previously, other countries have adopted different names for Alcomax-type alloys, whilst individual manufacturers may allocate trade names to standard compositions or modifications of the P.M.A. standard. Thus "Ticonal-G" is essentially the equivalent of Alcomax-III; Hycomax-I a modified version of Alcomax-II, and so on. The group or type of alloy can generally be established by a comparison of properties, although all manufacturers' figures do not necessarily conform to the same standard (see Performance Specifications).

Considerable confusion can, however, result in reading American designations as direct equivalents of British materials since the whole range of standard strain-hardening alloys is specified as "Alnico". It is also difficult to draw exact equivalents, although the following in a close approximation.

U.S. designation	*British equivalent*
Alnico–I	Intermediate between Alni and Alnico
Alnico–II A	High coercivity Alnico
–IIB	Alnico
–IIC	Normal Alnico
	High remanence Alnico
Alnico–IIIA	High coercivity Alni
–IIIB	Normal Alni
–IIIC	High remanence Alni
Alnico–IV	intermediate properties between Alni and Alnico
Alnico–V	intermediate or overlapping Alcomax–II and Alcomax–III
Alnico–VI	Alcomax–IV
Alnico–VB DG	Columax

In addition there are various cold-worked alloys known under specific trade names, a variety of little used permanent magnet alloys of non-standard composition, and in particular a whole variety of trade names for ferrite magnets (Ferroxdure, Magnadure, Caslox, Bismanol, etc.), and for pure iron micropowder magnets (although production of the latter appears to have ceased in Continental Europe, temporarily, at least).

Performance specifications

A somewhat similar variation of pattern is often to be found in quoted performance specifications, different countries—and even different manufacturers—employing different standards. Members of the British Permanent Magnet Association invariably quote average values consistent with average performance obtained with rectangular test blocks and based on a statistical survey of a random selection of production magnets. Tables I, II and IV are based on these data.

Standard practice in America is for manufacturers to quote minimum guaranteed values for a particular material, thus their figures (for an equivalent material) are normally less than British figures. Individual manufacturers (in all countries) may, however, publish maximum figures, or the ultimate performance of the material concerned, or a laboratory test figure obtained under unspecified conditions. German practice is to publish upper and lower values, the mean of which will normally agree quite well with British P.M.A. figures. French data, particularly relating to iron micropowders, are likely to be maximum figures.

Basic magnet theory

Before evaluating any particular magnet material for a specific design application a basic knowledge of the behaviour of permanent magnet materials is desirable in order to appreciate the significance of the performance data given for each material. Such knowledge, too, is essential for the design of magnets associated with a particular configuration and work requirement.

The process of magnetizing any normal ferromagnetic material consists of re-orientating a large proportion of the atoms to produce one artificially large "domain" (magnetic atom) in open circuit, as compared with the large number of small, individual domains in closed

Table III.—MAGNETIC PROPERTIES OF FEROBA

Condition	B_r Gauss	BH_{max} Mega-gauss-oersted	H_c oersted	Specific gravity	Curie point
Isotropic	2,100	1·0	1,750	4·8	450°C
Anisotropic	3,800	3·0	1,500	5·0	450°C

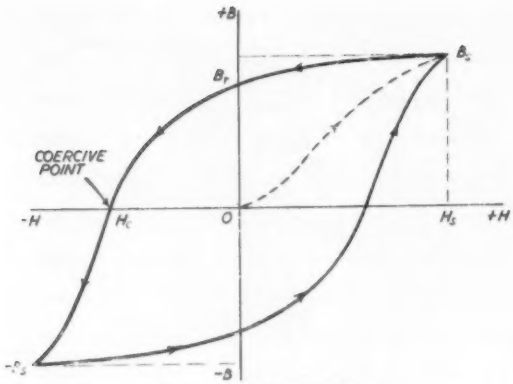


Fig. 1.—Typical hysteresis loop

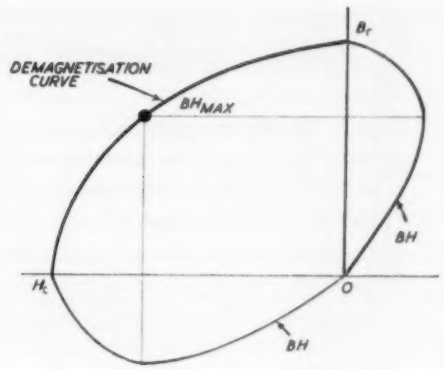


Fig. 2.—BH_{max} point on demagnetization curve

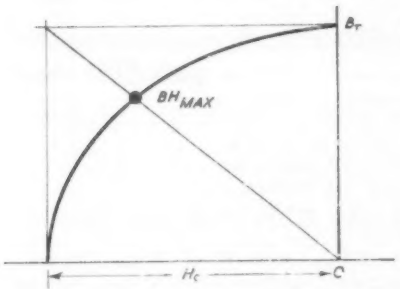


Fig. 3.—BH_{max} point by graphical method

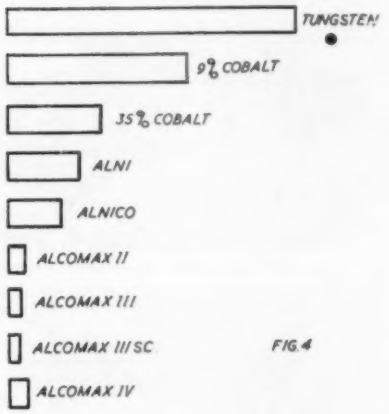


FIG.4

Fig. 4.—Comparison of equivalent magnet size for same performance and same cross section. In practice, cross section would be varied for optimum performance for similar volume

circuits in the unmagnetized state. When magnetized, there will be an inherent tendency for these original domains to reform in closed circuits again. Thus the essential difference between a "soft" and a "hard" magnetic material is that in the former case reformation can take place readily, whilst with a "hard" material re-orientation is prevented—obviously an essential requirement in all permanent magnet materials.

Starting with the material unmagnetized, and with the domains in random, closed circuit arrangement (point O, Fig. 1) the application of a magnetic field of sufficient force produces an increase in flux density B up to a point where the material is saturated (B_s). The magnetic field strength required to produce saturation is H_s (oersted) and is linked to the saturation flux density B_s by the equation

$$B_s = H_s + 4\pi J_s$$

where J_s is the saturation magnetization for the material involved. See Table X. Under this condition it is implied that all the domains have been re-orientated to be parallel with the field.

Removal of the magnetizing field results in a certain loss of flux (following the arrowed direction B_s to B_r on Fig. 1), but with zero magnetizing field the magnet retains a high proportion of the flux initially set up, which value (B_r) is known as the remanent induction, or simply the remanence of the material.

If, now, the magnet is subjected to a demagnetizing force, the flux will continue to fall until it reaches zero at some point defined by $H = H_c$. This is known as the coercive point and is the highest value of $-H$ or coercivity to which the magnet can be subjected before the flux reverses. By increasing the demagnetizing force still further, saturation will again be reached at $-B_s$.

If the magnetizing field is again reversed in direction and progressively increased, the flux density will follow the pattern shown up to B_s again, completing what is known as the characteristic hysteresis loop for the material. This loop largely defines the working properties of the material although it is necessary only to use the top left hand quarter of the diagram, since it is in this region only that the magnet will operate in service.

Redrawing this quadrant only, as in Fig. 2, we have a typical demagnetization curve by means of which the characteristic properties of permanent magnet materials are normally expressed. As a generalization, the greater the area under the curve the greater the efficiency of the permanent magnet, but other points are of more immediate significance. Analogous with electrical circuits which operate at maximum efficiency when the output and load impedance are matched, there is a condition of maximum energy in permanent magnet circuits. This corresponds to the maximum value of the product BH within the limits defined by the loop. If, for example, the product BH is plotted against B or H (both are shown in Fig. 2), a corresponding point can be marked on the demagnetization curve at BH_{max}. Normally this data would be given as a specific figure in a table of characteristics (see Table I, etc.), together with associated B and H values.

A close approximation to the BH_{max} point can also be established graphically from the demagnetization curve. Perpendiculars are erected normal to the H and B axes at the coercive point and remanence point respectively, and their point of intersection joined to the origin O. The intersection of this line with the de-

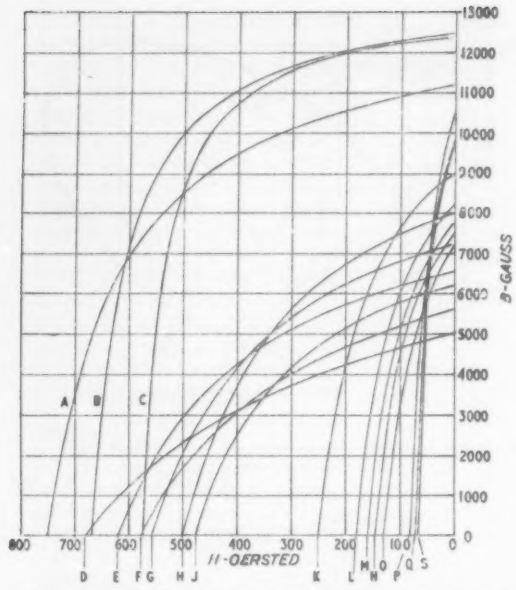


Fig. 5a.—Demagnetization curves for—A, Alcomax IV; B, Alcomax III; C, Alcomax II; D, Alni (high coercivity); E, Alnico (high coercivity); F, Alni (normal); G, Alnico (normal); H, Alnico (high remanence); J, Alni (high remanence); K, 35% L, 15% M, 9%; N, 6%; O, 3% cobalt steel; P, 2%Co 4%Cr steel; Q, chromium steel; R, 6% tungsten steel

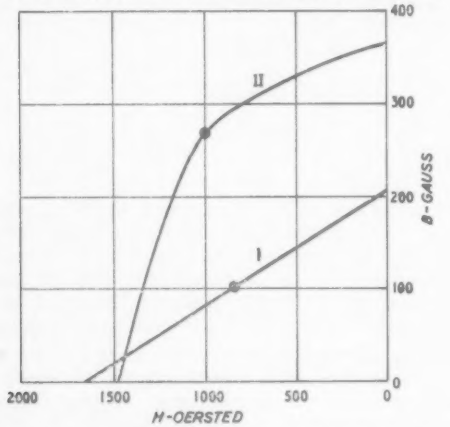


Fig. 5c.—Demagnetization curves for Feroba (isotropic —I and anistropic II)

magnetization curve establishes the approximate BH_{max} point, see Fig. 3.

The value of H_c corresponding to the coercive point is the coercive force or coercivity and is essentially a measure of the resistance to demagnetization. Whilst the BH_{max} value may be taken as a criterion of the efficiency of the magnet material, a high coercivity implies a high degree of permanency in the magnetism, and a minimum magnet length.

If the working point of the magnet is established at the BH_{max} point then the length, cross section and volume of the magnet required are all inversely proportional to

Table IV.—MAGNETIC PROPERTIES OF SINTERED MAGNETS

Material	B_r	BH_{max}	H_c	B at BH_{max}	H at BH_{max}
Alnico (normal)	6,500	1·5	530	4,700	320
Alcomax II	10,700	3·4	550	8,500	400
Alcomax III	10,800	4·1	600	8,550	480
Alcomax IV	9,000	3·5	700	6,750	520

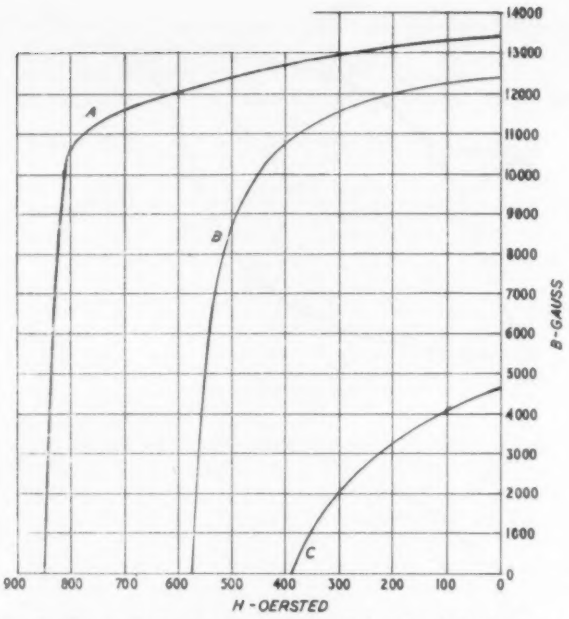


Fig. 5b.—Demagnetization curve for Alcomax II. B, in preferred direction; C, at right angles to preferred axis. Curve A is for fully-columnar Columax

the BH_{max}, B at BH_{max}, and H at BH_{max} figures, thus giving an immediate assessment of size of magnet required. Fig. 4 illustrates in simple diagrammatic form the respective sizes of magnets required for a similar duty in a range of different permanent magnet materials. The considerable saving in volume resulting from the selection of one of the modern dispersion-hardening alloys is most marked. Other factors may, however, affect the final choice (see Material Selection).

(*To be concluded*)

New Style Welding Electrode Holders

Two new electrode holders for manual arc welding named the "Handicool" 600 and the "Handicool" 600 (Insulated), are now available from Quasi-Arc Limited, Bilston, Staffordshire. Key feature is the new lever shape angled close to the handle to give better access to confined spaces. The handle and lever both have D-shaped cross-sections, providing a compact, well-balanced grip for welding in any position. The holders are designed so that they can be held with a "long" grip at the end of the handle when using high currents, or with a "short" grip close to the jaws to give a good control of the electrode tip. A notable point is that the holders keep exceptionally cool even after long periods of welding.

Insulating material round the jaws of the fully insulated version is tough, non-hygroscopic, resistant to heat and fracture, and is renewable when worn. Both holders have special deep-groove slots machined in the copper alloy jaws, including one along the axis of the holder to simplify overhead welding. The spring, situated behind the guard, is completely protected from spatter and is insulated.

Weight of the Handicool 600 is 21 oz, and of the Handicool 600 (Insulated) 23 oz. Maximum current is 600 amp, and the range of electrode sizes extends from 10 s.w.g. to $\frac{3}{8}$·in.

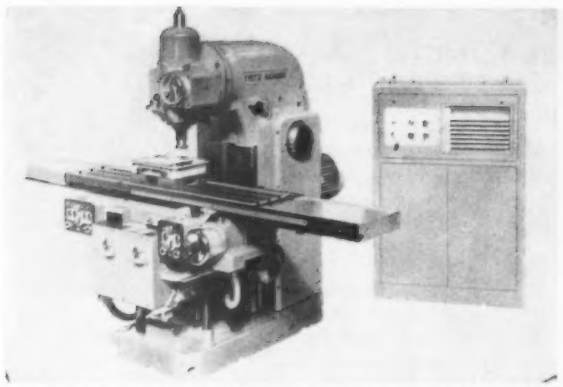


Fig. 1.—In this vertical miller by Fritz Werner control is automatic by means of the cabinet seen on the right

Programme Controlled 3-D Milling

A range of automatic three-dimensional programme controlled milling machines with table sizes ranging from 43 in. × 12 in. to 98 in. × 24 in. has been developed by Fritz Werner AG, West Berlin, for whom sole selling agents in the United Kingdom are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2. These machines, which are in both horizontal and vertical styles, are standard machines with the addition of a special control system and can, if required, be used as normal machines without any modification. An important feature of the programming equipment is that no tape, wire or punched cards are used.

Illustrated here (Fig. 1) is a Model FV4 vertical miller having a 71 in. × 17 in. table with a 20-station control cabinet. On the front of this cabinet there is a main control panel (upper left) which incorporates the master switch and selector switches for the direction of spindle rotation, coolant supply, etc. Up to four banks of push buttons determining the sequence of the machining programme enabling a maximum of 80 stages to be covered can be included in the cabinet. Each bank is enclosed by a lockable glazed door.

Twenty columns of buttons with fifteen buttons in each compose one bank. The columns are numbered from left to right and the programme stages are carried out in the numbered sequence. As each stage is initiated the corresponding number is illuminated. The function performed at each stage is selected by depressing the appropriate button in the column, an identifying symbol being provided at the end of each horizontal row as will be seen from the enclosed illustration.

Reading down from the top (Fig. 2) push button row 1 selects milling spindle rotation. Rows 2–13 select feed and rapid traverse motions in both directions of movement for the table, saddle and knee. Row 14 is for interrupting the programme at any desired stage, e.g. for cutter changing. The programme is restarted by a push button mounted on the machine saddle. Row 15 selects the end of the programme cycle.

Trip dogs on interchangeable carrier plates secured to the table, saddle and knee, control the lengths of traverses in each direction of motion. The use of these easily stored interchangeable carrier plates, together with push button masking templates, makes these machines equally suitable for small and large batches as job changeover can be effected in a few minutes.

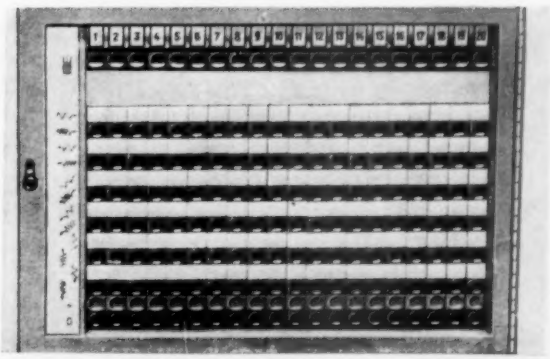


Fig. 2.—The push button panel of the control cabinet. The symbols at left indicate the motions controlled by the corresponding rows of buttons. The numbers at the top indicate the sequence of operations

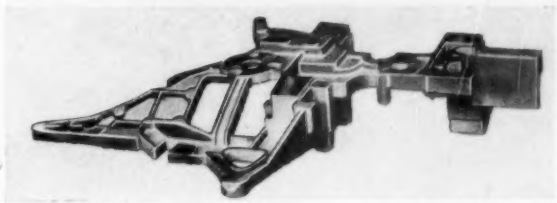


Fig. 3. (above)—This aluminium die casting was machined automatically. The controlled movements of the cutter are depicted in Fig. 4 (below)

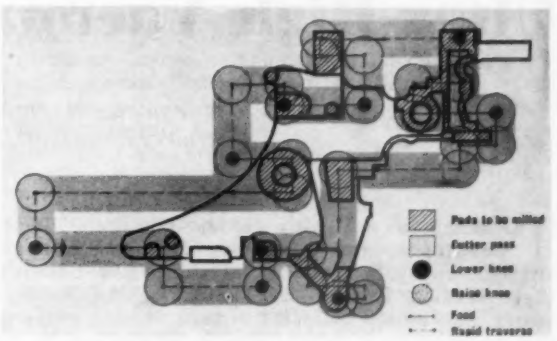
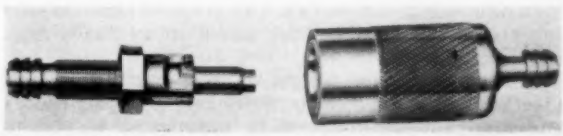
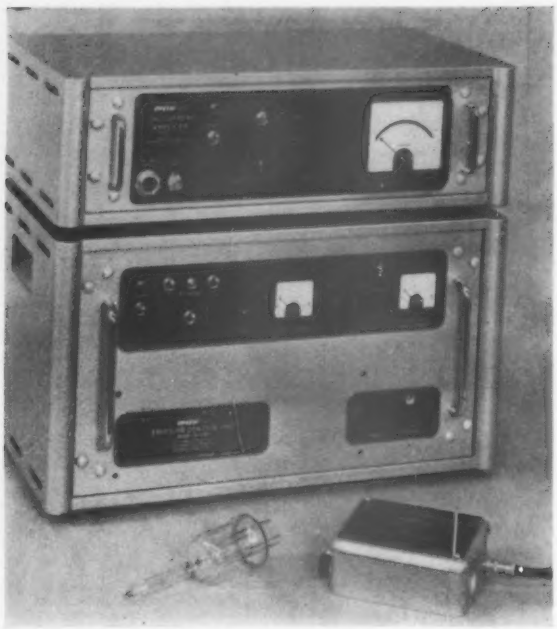


Fig. 3 shows an aluminium pressure die casting and Fig. 4 a diagrammatic layout of the cutter pass and rise and fall motions of the knee when machining this workpiece. A time of 3·4 min was required for the complete programme controlled sequence of operations compared with 12 min previously required.

Tests have shown that production time reductions of as much as 60–70% are very often achieved. An illustrated booklet giving further details of the machines is available on request to Rockwell Machine Tool Company Limited, at the address given above.



QUICK COUPLER.—The new Lockheed/Avery "Safelinc" coupling is suitable for the quick connexion and disconnexion of flexible hose lines carrying either air, oil or fuel. It is made by Automotive Products Company Limited, Leamington Spa



1 in. and 2 in. bore stainless steel, bakeable liquid air traps

Ion current amplifier and emission control unit in standard 19 in. rack cabinets, together with pre amplifier unit and glass ionization gauge head

Ultra-High Vacuum

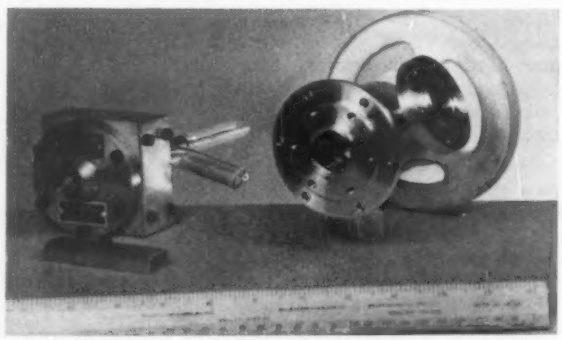
The equipment employed in the study of surface phenomena, gas discharges, nuclear fusion and ultra-pure thin films.

TO obtain a very high vacuum consistently with standard equipment has necessitated a thorough investigation by the research laboratories of Edwards High Vacuum Limited, of Manor Royal, Crawley, Sussex, into pumps, pumping systems, sealing methods and measuring equipment. New processes had to be applied to the production of components, resulting in different methods of fabrication, finishing and leak detection. The result is a complete range of equipment for ultra-high vacuum work which formed the subject of a display at the Physical Society's 44th Annual Exhibition (January 18–22).

Diffusion pump systems

Research has established that the classical diffusion pump systems are well able to produce pressures in the ultra high vacuum region. For this application pumps permitting negligible back diffusion of gas must be combined with single or multiple trap systems completely effective against back migration of vapour. Non-organic gaskets and superior internal finishes must be used in apparatus which can be baked to promote rapid degassing and which must be leak tested to unusually high standards.

The small size and weight of these pumping groups together with their comparatively high pumping speeds and straightforward operating techniques, emphasize the suitability of such apparatus, both for applications requiring the prolonged maintenance of very low pressures (e.g., for certain thermo nuclear machines) and for applications such as coating at ultra high vacuum where the shortest practicable cycle times must be achieved.



¾ in. and 1 in. bore stainless steel, bakeable right angle valves

Ultra high vacuum mercury vapour pumping group

The "Speedivac" pumping group consists of a mercury diffusion pump model 2M3B, surmounted by a water-cooled baffle model CBM2, and two liquid air traps type NTM2B. The whole group is constructed from stainless steel, and only metal gaskets are used on the high vacuum side.

The pumping group, provided with conventional backing arrangements, is provided with a generous working surface of heat resisting material with the top flange of the pumping system accessible through a hole in this surface.

Both liquid air traps are bakeable to 450° C and are provided with individual temperature controlled heating jackets. The apparatus to be evacuated requires baking, and an oven of suitable size to meet requirements can be mounted on the heat resisting work surface.

The liquid air traps operate for 15 hr without attention. Where necessary automatic trap maintenance can be arranged for prolonged trap operation and standard components are available for automatically dispensing liquid air to the traps from a standard dewar.

The apparatus is capable of producing pressures lower than 5×10^{-10} torr.

Ultra high vacuum vapour pumping group (oil)

The "Speedivac" mercury vapour pumping group described above can be directly replaced by a pumping group based on an oil diffusion pump. This pumping system consists of a fractionating oil diffusion pump F203, surmounted by a water-cooled baffle CB2, and a single liquid nitrogen trap NTM2A. The trap, bakeable to a temperature of 450° C, is provided with a close fitting heating jacket with temperature control arrangement. Metal gaskets are used throughout. The unit can be frame mounted in exactly the same way as the mercury vapour unit.

With the preferred operating fluid, Silicone 704, pressures below 5×10^{-10} torr can readily be obtained and held for long periods.

Getter-ion pumps

It is increasingly evident that the classical methods of pumping, using vapour diffusion pumps, cold traps and mechanical pumps will achieve pressures less than 10^{-10} torr. However, the possibility of eliminating the cold trap, and all organics is thought by some workers to be desirable.

It is too early to decide if the getter-ion pump will replace the classical pumping methods which are now under vigorous development. Small getter-ion pumps in glass envelopes have achieved ultimate pressures of about 10^{-10} torr and lower, but larger models having increased throughput do not appear to have produced vacuum better than 10^{-7} torr. Further, many of the larger getter-ion pumps have much larger physical dimensions and weight than vapour diffusion pumps of equivalent pumping speed. Notwithstanding these limitations, getter-ion pumps have potential use which many will want to explore for providing ultra high vacuum.

In many modern thermionic valves and devices the established technique of evaporating a getter film in the valve envelope is unsatisfactory. It is thus necessary to pump such tubes reliably for prolonged periods, often at elevated temperature, to ensure thorough outgassing. The possibility of eliminating both the presence of cold traps and organic vapours normally associated with diffusion pumps, stimulated interest in getter-ion pumping, in consequence compact getter pumps have been successfully developed for exhausting electronic tubes. The value of using getter-ion pumps in preference to conventional pumps on particle accelerators of large capacity has not yet been completely established. Although small getter-ion pumps in glass envelopes have produced pressures of 10^{-10} torr and lower, there have been difficulties in obtaining such performance with large pumps. Recent work in Edwards laboratories has culminated in the development of a getter-ion pump having appreciable mass throughput and giving ultimate vacua of about 10^{-9} torr. This work has developed from an entirely new method of using getter-ion pumps in combination with diffusion pumps. Care has also to be taken to ensure that well degassed metal is used for film deposit.

Getter-ion pump of high pumping speed with a titanium evaporation source of robust construction

The getter pump is constructed from argon arc welded stainless steel. The pump body 24 in. high by 12 in. dia has a 9 in. dia pumping port for attachment to the vacuum system. Demountable seals are made with aluminium wire gaskets. The vessel is pre-pumped by a 50 l/s diffusion pump, through a liquid air trap and a 'fluon' seated metal valve. The chamber can be baked to a temperature of 300° C by electron bombardment from a hot cathode (3 kV, 500 mA). After two hours baking and when cool, the pressure falls below 10^{-6} torr and gettering is then commenced. The getter is titanium evaporated from a molten bead suspended via a frozen zone, from a water-cooled copper block. The bead is heated by electron bombardment and replenished by a continuously fed wire. Problems of limitation of anode post life are avoided with this apparatus. The titanium bead can be grown to a large size and the feed stopped so that evaporation proceeds from gas-free titanium, at a low pressure. A power input of 1 kV and 500 mA, suffices for evaporation. Keeping the diffusion pump in operation during pumping assists in removing gases which are not effectively getter pumped.

Ultimate pressure

During titanium evaporation with diffusion pump	2×10^{-8} torr
After titanium evaporation with diffusion pump along	4×10^{-9} torr
After titanium evaporation with ion-pump along	10^{-8} torr

Pumping speed for nitrogen (at 10^{-6} torr).
3000 l/sec isolated from diffusion pump.
4500 l/sec with diffusion pump in operation.

Penning pump

A small Penning ion-pump fitted with titanium cathodes as proposed by Gurewitsch and Westendorp has a body made from stainless steel with a glass to metal lead-in electrode and bakeable metal gasket seals. The pump operates with a maximum power input of 3 kV, 15 mA, and uses a 400 gauss magnet. The pumping port is 56 mm dia and the titanium cathodes are 50 mm dia. Pumping can be started at a pressure of 10^{-1} torr and an almost constant pumping speed of about 5 l/s obtained for N_2, O_2 and air at pressures below 10^{-3} torr. Ultimate pressure depends on the extent of degassing and pressures down to 10^{-8} torr have been obtained after baking. When a Penning pump is used as an ion-source with evaporated Ti-films, the mass sorption rate of the deposit directly depends on the ionization current flowing, as shown by Holland and Harte.

Instrumentation and seals

The extended range of the Alpert type ion gauge and its stimulation on the measurement of very low pressures is not without inherent disadvantages, particularly as

regards the pumping action which accompanies its operation. This makes possible the use of the gauge as a low speed pump, as used in the Alpert technique of evacuating small vacuum systems. It is equally important to be able to avoid pumping action and this facility is available in gauge control units and ionization current amplifiers.

In any vacuum system it is important to eliminate the possibility of error arising from tubulated connexions between the gauge and the system. This factor assumes particular importance at very low pressures and has led to the development of the wide bore all metal demountable ultra-high vacuum ionization gauge head. This and similar requirements led to the techniques of all metal bakeable demountable vacuum seals and high temperature electrode seals, which have many other applications.

"Speedivac" metal ultra-high vacuum ion gauge head model IG-3M

The gauge head was developed to meet the requirements of demountable metal systems and the elimination of the effects of pumping action by the provision of a wide bore vacuum connexion. The gauge head is constructed from stainless steel and may be baked to temperatures of 450° C for degassing. It has an electrode structure electrically similar to the well-known "Speedivac" Model IG3H series of gauge head, but with readily replaceable filaments.

"Speedivac" emission controller Model 1

This instrument provides four ranges of fully stabilized grid current, from 10 mA for ion pumping to 10 μA for low pressure measurement. Facilities are provided for the intermittent application of gauge potentionals for low pressure measurements and minimum interference from ion pumping. In the event of exceptional pressure rise in a system, the ion gauge filament is fully protected by an integral overload cut-out incorporated in the instrument. Outgassing facilities are provided with an available power of 100 watts. To suit a wide range of ion gauge heads, filament voltages of 6 v, 10 v, 15 v, are available at currents to suit all known types.

Ion current amplifier "Speedivac" Model 2

The instrument consists of a sensitive d.c. amplifier, with a separately housed electrometer input stage, which can be mounted in close proximity to the ion gauge. It is provided with a "backing off" control, making it suitable, in conjunction with an ion gauge, for leak detection at very low pressures using any one of a selection of tracer gases. Ionization currents in the range of 3×10^{-5} amp to 2×10^{-15} amp can be measured.

When the amplifier is used in conjunction with the "Speedivac" emission regulator described, and an ion gauge of the "Speedivac" IG3 series, pressures in the range of 10^{-3} torr to 10^{-11} torr can be measured.

Metal gaskets, seals and components for very high vacuum

The production of very high vacuum requires the construction of systems in which organic sealing materials are eliminated and in which the complete system can be baked to high temperatures to accelerate outgassing. Such systems must also be constructed and assembled to exceptional standards of cleanliness and leak tightness.

During the last few years the literature reports multitudinous methods for providing all-metal seals and joints in vacuum systems. Many of these sealing methods have been investigated by the company's research sections.

Application examples

Ultra-high vacuum coating unit

Recent research has indicated that the poisoning of contact spot electrodes applied to semi-conductors, inconsistencies between thin film nickel/iron magnetic storage units and protracted switching time in tin/lead Cryotrons, may be due to contamination by traces of gas present during vacuum processing at the currently accepted pressures of 10^{-4} torr. These same processes carried out at much lower pressures considerably reduce contamination and the ability rapidly to produce pressures in the very high vacuum region can be expected to be increasingly exploited in applications of vacuum coating. The plant described below has been produced for research into these gas contamination mechanisms, as well as for other work concerning the adhesion and bonding between evaporated films.

A "Speedivac" vacuum coating plant model 12E8, for producing pure, thin metal films, at very low pressures, has a 12 in. dia and 15 in. high work chamber, trap and pumping connexions all made of stainless steel and can be baked to a temperature of 450° C for outgassing. A water-cooled baffle is mounted above the diffusion pump to prevent it overheating during baking. The pumping system consists of a 2 in. liquid air cooled trap, water cooled baffle and F403 fractionating oil diffusion pump. When the ultimate vacuum attainable with the conventional pumps is reached, a getter is fired in a subsidiary chamber for rapidly reducing the pressure still further.

Demountable seals of aluminium wire gaskets and H.T. and L.T. lead-in electrodes of the glass to metal and ceramic to metal type are used throughout.

Typical pumping performance:

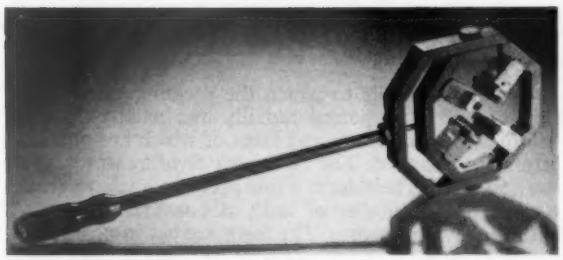
10^{-7} torr obtained after 1 hr pumping without baking.
10^{-8} torr obtained after 2 hr baking.
10^{-9} torr range obtained after baking and firing getter.

Automatic and fully instrumented synchrotron pumping group

Pumping systems for high energy accelerators must reliably ensure the attainment and maintenance of the requisite low pressures; further the pumping group must operate remotely and automatically. Many of the special techniques, accessories and components used on the system find application in other fields of vacuum practice.

Forty pumping groups are being currently supplied to the Rutherford High Energy Laboratory at Harwell for the 7GeV Proton Synchrotron, together with automatic instrumentation and control unit. In these the 24 in. fractionating high speed oil diffusion pump is fitted with refrigerated chevron baffle and full bore, high vacuum gate valve. This valve is arranged and connected to give controlled throughput during opening, and for rapid closing under fault or emergency condition. The diffusion pump is backed by a vapour booster pump and conventional mechanical pump, an arrangement giving optimum performance, size, weight and cost advantages.

Pressure, thermal and time control switches are fitted at various points on the pumping group to ensure automatic correct sequential operation of the pumps during "start up" and automatically ensuring that should any operational fault develop, the unit will take action to protect itself and the system being pumped.



This new lathe accessory carries four honing stones. It is held in the hand and thus automatically follows the throw of a cranked shaft

Honing Tool for the Lathe

A new lathe tool for honing and superfinishing straight or cranked shafts has been introduced by Nicol and Andrew Limited, Hillington, Glasgow SW2. Called the "Lathe Hone", this tool is an addition to the range of the company's motorized "Master Hones" which have been designed to operate on shafts up to 24 in. dia with a minimum amount of dismantling.

The Lathe Hone is non-motorized, and consists of a split head carrying four abrasive stones in shoes, which is clamped round the workpiece on the lathe. A centre spindle attached to the hand screw adjustment passes through the main support rod, permitting finger-tip control of abrasive stone pressure on the workpiece. The main support rod travels through a sleeve which is pivoted on a secondary rod working within a sleeve block located in the lathe tool-post.

The Hone automatically follows the "throw" of a cranked shaft revolving in the lathe while still under pressure control by the operator. The secondary rod being held firmly in the sleeve block allows lateral stroking movements on the workpiece.

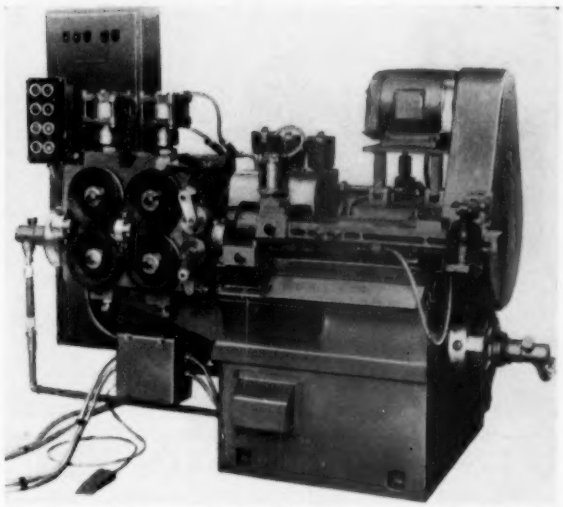
The Lathe Hone is available in four sizes, A, B, C, and D, for diameters 2 in. to 4 in., 4 in. to 6 in., 6 in. to 9 in. and 9 in. to 12 in. respectively. The size of the lathe bed is the only limit to the length of shafts which can be honed and superfinished.

Automatic Cutting-off Machines

A new range of fully automatic machines for cutting-off steel bars into lengths for the hot forming of bolts has been introduced by Maschinenfabrik Peltzer & Ehlers, Krefeld, West Germany, for whom the sole agents in the United Kingdom are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2. The accompanying photograph shows the smallest machine in the range.

The machines produce accurate, uniform lengths with flat, right-angled faces. Output depends on the cut-off length, the maximum being 60–75 pieces per min. The cut-off length is infinitely variable up to 36 in. according to machine size and attachments enable any desired length to be obtained. The minimum length should not be less than the diameter of the material. Round, square, hexagon or rectangular section material can be cut and providing the shearing capacity of the machine is not exceeded, two bars can be cut simultaneously.

Cut-off and feed mechanisms are controlled by a compressed air-operated clutch and brake, and air-operated feed rollers grip the material, the action of these rollers being synchronized with the machine cycle. The feed rollers are adjustable, within limits, to the material dimensions and rollers can be obtained with profiles to



The smallest of the new range of Peltzer & Ehlers bar cut-off machines will shear up to ½ in. dia bar

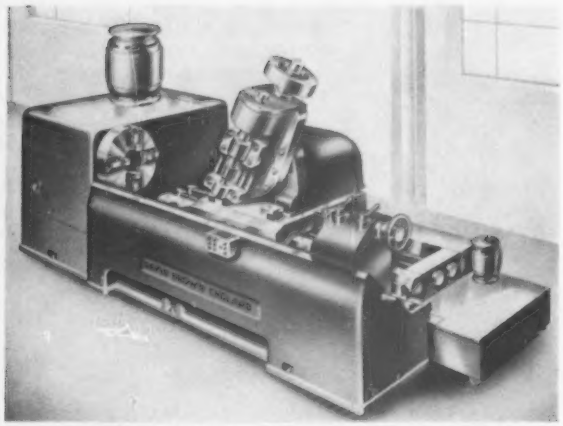
suit the material section. Alternatively, V-grooved rollers can be used so that two or three sets cover the capacity of the machine. For especially sensitive surfaces, rollers with plastic coatings are available. For feeding two bars simultaneously, the upper rollers are provided with a compensating device enabling bars of different limits to be fed at the same speed and thus produce the same cut-off length. Resetting the machine for different sections is simple and quick. Both the upper and lower rollers are provided with height adjustment or they can be easily exchanged for another set.

From the feed rollers the material passes through guide bushes and the open cutter blades until it contacts an electrical control stop clamped in position to suit the required cut-off length. Actuating this stop arrests the feed mechanism and starts the shearing action. Completion of the shearing action automatically re-engages the feed drive to commence the next cycle. An ejector immediately behind the upper cutter blade presses the cut-off bar end downwards to fall clear of the machine. To produce clean and straight cut-offs the blades are made to suit the section of the material being sheared. The blades are easily accessible and quickly changed.

On the smallest machine, coiled material up to a wire diameter of ½ in. can be sheared if required and for this a removable straightener is built on to the ingoing side of the machine at extra cost.

Surface Reinforcement for Concrete Floors

A new product called Hexweb is proving very successful for reinforcing concrete floors. Manufactured by Causeway Reinforcement Limited, Five Ash Works, Dover Road East, Northfleet, Kent, it is a webbed chilled cast-iron floor grid designed and chemically toughened to meet the load demands of the heavier industrial floors. Each grid is hexagonal in shape, and has a mean diameter of 11½ in. The grids are laid in a concrete wet mix and infilled with a stiff infiller. This combination provides a flooring of long life which resists wear under rolling and shock load, and offers resistance to corrosion and is anti-skid. Individual grids can be removed from the floor without disturbing the adjacent grids.



This new David Brown pinion hobbing machine is designed for the rapid and accurate production of double helical pinions up to 12 in. (305 mm.) dia with overall facewidth up to 30 in. (750 mm.) and overall shaft length up to 80 in. (2030 mm.)

New David Brown Pinion Hobber

A new precision pinion hobber is the latest addition to the David Brown range of gear hobbing machines. Known as the P12H, its accuracy is well within the tolerances permitted in British Standard 1498/1954 Grade A. Built by the David Brown Machine Tool Division, Manchester, the machine is designed for hobbing double helical pinions up to 12 in. (305 mm.) dia with overall face width up to 30 in. (750 mm.) and an overall shaft length of 80 in. (2030 mm.). As such it is complementary to the maker's MT50 gear hobber, which can accommodate gears up to 62 in. dia. The provision of a pinion hobber of this size meets a known requirement in the shipbuilding and electrical industry. Apart from the wide range of pinions it is capable of producing at economical cost, the P12H machine, which is considerably smaller than the turbine pinion machines in current use, greatly simplifies the problem of floor-space.

All the essential features for the production of gears of the utmost precision have been incorporated in this machine. It has liberally proportioned slideways, large diameter work spindle, hob spindle bearings and large diameter feed screws to ensure the rigidity necessary for maintained accuracy over a long working life. Extensive use is made of hardened and profile ground gears and all high speed shafts are mounted on ball or roller bearings. All main castings are of close grained pearlitic iron to British Standard 452/1948 and those that affect the accuracy of the machine are stress relieved to ensure the utmost stability under all cutting conditions.

The large diameter, fine pitch, dividing worm wheel is of special phosphor bronze which has been proved to have the best wear-resisting qualities. The mating worm is of 2% nickel molybdenum steel, casehardened and ground; and the lead screw is of 0·4% carbon steel which has the necessary free-cutting qualities to permit a high-class finish being obtained on the thread flanks and the minimum of wear on the cutting tool.

Permanently mounted measuring equipment is incorporated and accurately ground dividing plates are provided for mounting on adaptors on the dividing worm and lead screw, also on the hob arbor for checking uniformity of motion between hob and work spindle, and on the dividing worm and work spindle.

The work spindle to which the dividing worm wheel is attached, is supported radially and axially on large bearings, the diameters and faces of which are precision ground and lapped. The 20 in. dia dividing worm wheel has 150 teeth. These have a low pressure angle to ensure the maximum number of teeth in simultaneous contact with the dividing worm. The teeth are cut in position on the work spindle, on a specially designed master worm wheel generator, and the tooth spacing accuracy is well within specified limits.

The 4 in. dia lead screw is mounted near the locating V-guide of the hob saddle. Extreme care is taken in the manufacture of this vital component and, in order to minimize distortion the screw is subjected to normalizing and stress relieving heat treatments between machining operations. The thread is cut on the David Brown master screw cutting lathe under strict temperature control and is measured in position. A certificate of accuracy is supplied with every lead screw. Axial location of the screw is by means of casehardened, ground and lapped flat thrust washers located at one end of the screw. The nut assembly which is mounted on the hob slide comprises two separate nuts widely spaced: one of these is permanently mounted, the other being arranged so that it can be rotated by means of worm and wheel, relative to the fixed nut and so eliminate backlash.

The design of the differential gear has received particular study to eliminate errors. It comprises casehardened and profile ground spur gears mounted on ball bearings.

The machine is provided with motor-operated rapid traverse for the hob saddle for use when setting up and limit switches at extreme positions to prevent overrun.

In addition to the tail stock for supporting the work, two additional work steadies are provided and the sizes of these can be varied to suit users' requirements.

Automatic lubrication is provided for all gears and bearings, the circulation pump being motor driven and electrically interlocked with the main motor to prevent the machine being started until the oil is in full circulation.

Surface Finish Measuring Microscope

A surface-finish microscope shown by Hilger & Watts Limited at the Physical Society's Exhibition is an interferometric instrument for measuring the depths of surface irregularities direct to the millionth part of an inch. Light from a mains-operated mercury lamp passes through an adjustable iris diaphragm. A lens system directs the light through a semi-reflecting optical flat and on to the surface to be examined. The flat is inclined to the surface and so encloses a wedge-shaped air space. Multiple reflection between the surface and the flat produces interference fringes, the irregularities of which correspond to the irregularities in the surface. They can be estimated to one millionth of an inch, that is, one tenth of a fringe spacing, by means of the microscope which magnifies 120 times. A camera is available for recording the fringes photographically. The optical flat is specially mounted to bear very lightly on the surface, so that comparatively soft surfaces can be examined.

Earth Leakage and Earth Fault Protection—IV

Electric Shock Risks

By J. L. WATTS

WHERE a low-voltage electricity supply is derived from an outside source, one point of the system is normally connected to earth as in the case of the neutral point of the three-phase four-wire system indicated in Fig. 1. The voltage between each phase and neutral of a three-phase supply is $1/\sqrt{3}$ of the voltage between phases; thus the phase-to-neutral voltage V_n of a standard 415 volt three-phase supply is 240 volts. So long as the impedance of the neutral-point earthing connexion is negligible this earthed point limits the voltage between each phase of such a supply and earth to 240 volts.

Non-earthed supply system

Where the supply is from a private generating plant or from the low-voltage secondary windings of a transformer, it sometimes happens that the supply is insulated from earth. If the insulation of the system was perfect

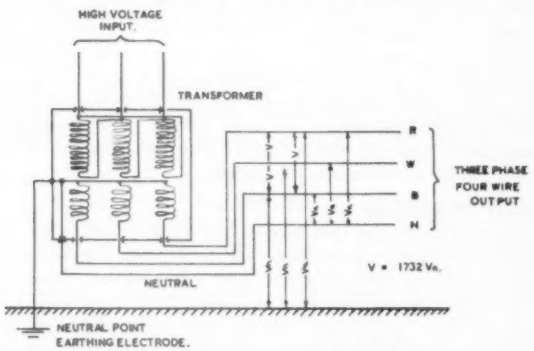
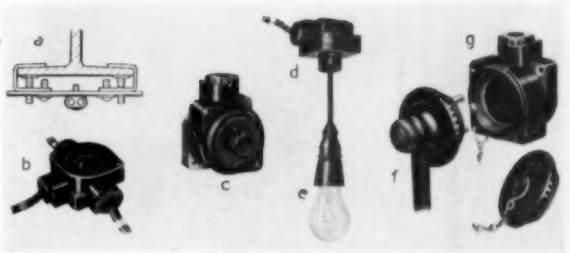


Fig. 1.—Three-phase four-wire supply from transformer

no particular voltage would then exist between current-carrying conductors and earth, nor between metallic conduits, sheathings and casings and earth; and this condition would be maintained unless an earth fault occurred at one point. However, since no insulation is perfect, voltage will exist between current-carrying conductors and earth, even when no earth fault exists. In the event of earth leakage or an earth fault, voltage would then exist between the exposed metalwork of the conductors and earth, which might introduce a risk of fire or electric shock. If an earth fault occurred on two phases some of the exposed metalwork might become "alive" at up to the full phase voltage to earth. This voltage might persist if the metallic parts were not bonded together to allow the resultant short-circuit current to operate the excess-current protective devices.

With such an insulated system there is a risk of persistent arcing to earth, and protective devices cannot be used automatically to switch off the current when a potentially dangerous earth leakage occurs. It is, therefore, inadvisable to use an insulated system if the voltage is sufficient to introduce any serious risk of shock; or if the capacity of the system is such that there may be a risk of fire due to arcing to earth.



British Insulated Callender's Cables Limited.

Fig. 2.—Various all-insulated accessories

Shock due to earth leakage

One of the most serious potential consequences of earth leakage or an earth fault on any electrical system is that it causes exposed metalwork round the conductors, such as conduit, cable sheathings or metal casings, etc., to become "alive" at a certain voltage to earth. The function of the earth-fault protective gear should be to cut off the current automatically if the leakage is such as to cause a risk of fire or electric shock. As previously described, closely-rated fuses or correctly-set overload circuit-breakers, combined with sound installation and maintenance, may provide good protection against fire risks, although better protection against risk of fire is provided by leakage devices which operate on comparatively low fault currents, as will be described later.

However, consideration of the effects of electric current through the body shows that leakage currents, which may be so small as to involve little risk of fire, might cause a serious, possibly fatal shock. It would appear that the protective arrangements on many installations may allow dangerous conditions to persist, and protection against shock risks may involve more stringent conditions than are generally realized. Every year persons are killed and injured by electric shock largely resulting from earth leakage or earth faults. There is no doubt that purely fortuitous circumstances limit the number of fatalities; i.e. persons in the vicinity may not be in contact with exposed metalwork under earth-fault conditions, or may not be in contact with earth or with conducting materials in contact with earth. Wooden floors, carpets, non-conducting soles of shoes, etc., have saved many from serious electric shock.

Physical effects of current

The ultimate effects of given currents through the human body are hardly matters for experiment, but a certain amount of information is available. It is known that a normal fully-clothed healthy man has been killed by electric shock at less than 60 volts a.c. at 50 cycles,

Gilflex Conduits Limited.

Fig. 3.—Plastic conduit on a grain dryer installation

although the duration of the shock current is unknown. The amount of current which may pass through the body of a person who is in contact with metalwork to which earth-leakage current flows, and is also in contact with earth or conducting materials in contact with earth, depends on two factors. These are the voltage existing between the metalwork and earth, and the resistance of the body between the points of contact.

The body current in milliamps is equal to

$$\frac{1000 \times \text{voltage}}{\text{Resistance (ohms) between contact points}}$$

The effects experienced depend on the value of the current; the duration of the current through the body; the route of the current through the body, which depends on the points at which contact is made; and may also depend somewhat on the physical characteristics of the person concerned.

Suggested minimum safety requirements

An alternating current of 15 to 25 milliamps (mA) may cause muscular contraction. If this persists the person may be unable to remove himself from the source of shock, and if the current is not cut off it is possible that asphyxia may occur in a relatively short time. Breathing may be restored if artificial respiration is applied immediately. The most dangerous points of contact appear to be the two hands, or one hand and one or both feet, which are the most likely points of contact. Current flowing between such points affect the cardiac region.

It appears to be generally agreed that a current of 70-100 mA through the cardiac region may cause death by interruption of normal heart action, if this current is allowed to continue for more than about a second. It would, therefore, appear that for reasonably good protection from serious shock risk the system should be designed to prevent a current exceeding about 15 mA continuing to flow through the body, and to prevent a current of about 80 mA flowing for more than about a second. In view of the possibility that a shock might cause a person to receive indirect injury by falling it is, of course, desirable to limit the possible body current to even lower values, if practicable.

The resistance of the body appears to be mainly concentrated at the points of contact. Whilst the average resistance with dry hands may be about 3,500 ohms, this may fall to 1,000 ohms or so if the hands are wet or perspiring, and the latter effect may tend to be promoted if shock current continues to pass through the body. With a body resistance of say, 3,000 ohms, 15 mA would pass if 45 volts was applied between the two parts of the body, whilst 80 mA would pass if 240 volts was applied.

Even under good working conditions, therefore, it would appear that on a standard 240 volt a.c. system the protective gear should be arranged to cut off the current in no more than about one second if an earth fault occurs which may make exposed metalwork alive at about 240 volts to earth, and to prevent leakage current or earth fault allowing the metalwork to remain alive at more than about 45 volts to earth.

If the apparatus is used under adverse conditions, i.e. where the hands or feet may be damp, it is advisable that standard voltage supplies should be cut off in a much shorter time, say about 0·1 sec in the event of an earth fault; or that a lower voltage be used. It may be noted that the I.E.E. Regulations state the desirability of limiting the maximum voltage between the exposed metalwork and the consumer's earthing terminal to 40 volts, under earth-fault conditions.

Safety Precautions

Preventative and protective methods both play an important part in avoiding risk of shock. The installation should be well designed and constructed, conduits and cables firmly secured so that they cannot make contact with unearthed metal, and all equipment installed in such a way that it is free from danger due to extraneous causes, such as mechanical impact or abrasion, heat and moisture. Periodical tests of the insulation resistance of the whole installation should be carried out so that any developing weakness of the insulation can be detected and remedied in good time.

One method of avoiding risk of shock due to earth leakage or earth fault is to use apparatus which is so designed that persons cannot make contact with parts which become "alive", even when the normal insulation is faulty. Another method is to use equipment which operates at a voltage which is too low to be dangerous. However, these methods are not universally practicable and the usual method is to earth the exposed metal parts and to employ protective devices which cut off the current if the exposed metalwork becomes "alive" at a dangerous voltage.

I.E.E. regulations

The I.E.E. Regulations do not, in themselves, have any statutory authority. However, they set a good standard for electrical installations, and are intended to be cited for contractual purposes to supplement

statutory provisions. Reference may also be made to Codes of Practice issued by the British Standards Institution.

The I.E.E. Regulations require that protection be afforded against dangerous earth-leakage currents on circuits operating at more than 30 volts a.c., or more than 50 volts d.c.; either by using (all-insulated) apparatus which is completely enclosed in durable insulation, by using double-insulated apparatus, by earthing of exposed metal parts, by the use of earth-leakage circuit-breakers, or by isolation of the metal so that it is not liable to come into contact with "live" parts or with earthed metal.

All-insulated apparatus

There are on the market many "all-insulated" types of switch and fuse boxes, distribution fuse boxes, connexion boxes, switches, lampholders, socket-outlets and other apparatus which are suitable for low-current circuits. Some of these fittings are shown in Fig. 2. They are mainly designed for use with an "all-insulated" wiring system which may employ vulcanized-rubber insulated and tough-rubber sheathed cables, or P.V.C.-insulated sheathed cables.

Plastic conduits of specially-compounded P.V.C. are also obtainable which can be used for lighting or power circuits. The Gilflex plastic conduit is illustrated in Fig. 3. Pitch-impregnated fibre ducts and accessories are obtainable for under-floor wiring. When used with metal-sheathed apparatus an earth-continuity conductor can be run through the plastic conduit or fibre duct, or contained in a composite cable, for earthing the metal casings.

There is much in favour of using an "all-insulated" system, particularly when earthing conditions are difficult, since this avoids metal parts which may become "alive" or touch other systems such as gas piping.

Double-insulated apparatus

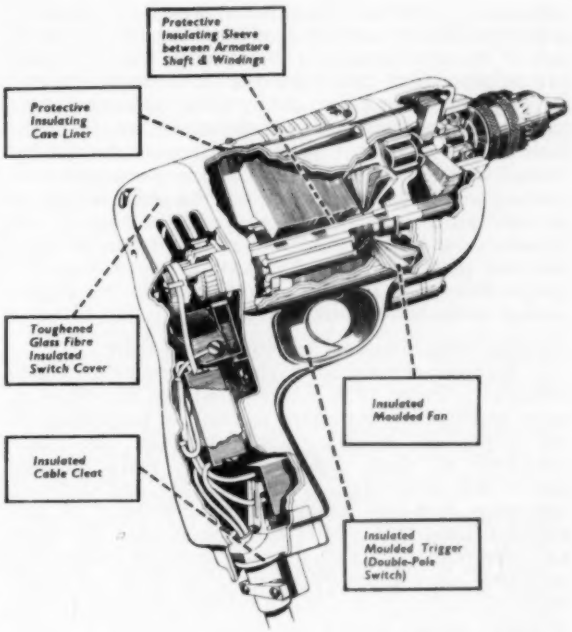
An appliance is "double-insulated" when, in addition to the normal (functional) insulation of the current-carrying parts, further insulation is provided to protect against the risk of shock in case of failure of the normal insulation. This type of construction is particularly suitable for portable apparatus where there may be a special shock risk due to the person holding the apparatus, or due to the conditions under which the apparatus may be used. Double-insulated apparatus does not need earthing. Fig. 4 shows a small portable drill of double-insulated construction.

Portable lampholders should always be shrouded in durable insulating material so that the lamp cap cannot be touched, and should be fitted with a wire guard which is not in contact with the metalwork of the lampholder, so that the appliance is virtually "double-insulated".

Earthing required by I.E.E. regulations

In places where earthing is required the I.E.E. Regulations call for this to be applied to all metalwork associated with the wiring system (other than current-carrying parts), including cable sheaths and armour, conduit, ducts, boxes and catenary wires, exposed metalwork of apparatus and earthing terminals of socket-outlets.

One point of the secondary winding and metalwork (other than current-carrying parts) of any transformer used on a consumer's installation is required to be earthed (other than one contained in an item such as a radio set). However, earthing of one point of the secondary winding is not required on a high-reactance transformer used solely to supply a tesla coil or the heating coil of a discharge lamp; a double-wound transformer in which the primary and secondary windings are separated by an earthed metal screen; or an approved dry-shaver supply unit.


Protective Insulating Sleeve between Armature Shaft & Windings
Protective Insulating Case Liner
Toughened Glass Fibre Insulated Switch Cover
Insulated Cable Cleat
Insulated Moulded Fan
Insulated Moulded Trigger (Double-Pole Switch)

Wolf Electric Tools Limited.

Fig. 4.—A "Double-insulated" portable electric drill

The I.E.E. Regulations exempt from earthing certain metal parts which are isolated so that they are not liable to come into contact with "live" parts or with earthed metal. Such parts are as follows:—short isolated lengths of conduit used for mechanical protection of T.R.S.—or P.V.C.—sheathed wiring; short unexposed isolated lengths of conduit used for mechanical protection of cleated wiring where it passes through floors, walls, ceilings or partitions; short isolated lengths of catenary wire used with T.R.S.—or P.V.C.—sheathed wiring; cable-fixing clips; metal boxes for T.R.S.—or P.V.C.—sheathed wiring systems, if screened by non-conducting material; lamp caps; metal suspension chains for lighting fittings, not in contact with twisted flexible cord; filament lighting fittings in a room having a non-conducting floor, if these fittings are out of reach of earthed metal and are at such a height that they cannot readily be touched.

Cinematograph regulations

The Cinematograph Regulations require that all metalwork liable to become accidentally charged shall be efficiently earthed. All fixed cables and wires for the projector circuits must be armoured or contained in heavy-gauge screwed conduit; the armouring or conduit being efficiently earthed.

Earthing required by quarries electricity order

In premises coming under the Quarries (Electricity) Order, 1956, fixed cables operating on more than 25 volts, and flexible cables operating on more than 125

volts a.c. or more than 250 volts d.c., must have a metallic covering. Efficient earthing is required for every metallic part of electrical apparatus fed at more than 125 volts a.c. or more than 250 volts d.c. (other than current-carrying conductors) and for metallic coverings, containers or mountings of such apparatus, and metallic parts of any equipment which may become charged by contact with any conductor, unless these parts cannot be touched whilst the circuit is "alive". The metal casings of portable apparatus must be earthed. Earthing of the secondary windings of a step-down transformer, or other means of protection, must be provided to guard against danger due to leakage or induction from the higher voltage to the lower voltage side.

Earthing required by coal and other mines order

In premises coming under the Coal and other Mines (Electricity) Order, 1956, it is required that the following parts be efficiently connected to earth at the surface of the mine:—all metallic cable coverings, the outer conductor of every concentric cable, every metallic part of any covering of, or mounting for, any electrical apparatus, and any handle for the operation of any electrical apparatus, operating on more than 125 volts a.c. or more than 250 volts d.c.; together with the metallic casings of portable apparatus. Earthing of the secondary winding, or other means of protection, must be provided to guard against danger due to the charging of lower voltage components by contact with or leakage from the higher voltage components.

Earthing required by Factories Acts

The Electricity Regulations of the Factories Acts require earthing of exposed metalwork of all portable apparatus, and flexible metallic coverings of cables used with such apparatus, which operates on more than 250 volts. In places where a person holding a portable appliance, or switched lampholder, may be liable to receive a shock through a conducting floor, conducting work or otherwise, the exposed metalwork of the portable appliance, any flexible metallic covering of cables, and metallic casings of switched lampholders must be earthed if fed with a.c. or more than 150 volts d.c.

Where necessary to prevent danger, i.e., where a person may touch the metalwork whilst in contact with a conducting floor or earthed metal, etc., the exposed metalwork of apparatus operating on more than 125 volts a.c. or more than 250 volts d.c. must be earthed as follows:—metal armouring, sheathing and conduits of cables, switch and fuse boxes and covers and handles, metal suspension and stay wires, and metal casings of electrical plant.

American Practice

It may be noted that the practice of the companies of the American G.E.C. is to bond exposed metalwork of electrical services to other earthed metalwork, such as structural steelwork, within six feet of the electrical equipment, unless the two systems of metalwork are mechanically inter-connected by structural steelwork, conduit or the like, with a circuit of less than 100 ft between them. Where bonding is adopted between two such systems a bare copper conductor of not less than 0·45 in. dia is used.

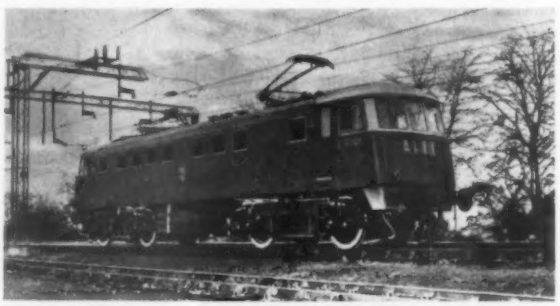
The author's thanks are due to the various manufacturers who have kindly supplied illustrations.

Locomotives for British Railways

A.C. machines operating from 25,000 volt supply with mercury arc rectifiers

IN connexion with the modernization plan for British Railways, The British Thomson-Houston Company Limited, now incorporated in the A.E.I. Traction Division, is supplying 25 complete locomotives, the mechanical parts for which have been sub-contracted to The Birmingham Railway Carriage & Wagon Company Limited, of Smethwick, Staffs. They have been designed to the general requirements of the B.T.C. under the overall direction of Mr. S. B. Warder, Chief Electrical Engineer, and Mr. J. S. Harrison, Chief Mechanical Engineer, British Railways Central Staff. There will be 23 type A locomotives, of which E.3001 is the first, geared for a top speed of 100 mph and two type B locomotives suitable for a top speed of 80 mph. Principal technical particulars of the locomotives are as follows:

	Type A	*Type B*
Wheel arrangement ..	Bo–Bo	Bo–Bo
Horsepower at 1 hr rating of traction motors	3680	3680
Top speed, mph ..	100	80
Weight, tons	80	80
Brakes	Vacuum controlled	Straight air on locomotives
Max. tractive effort at peak notching current ..	48,000 lb	60,000 lb
Tractive effort at continous rating of motors	20,000 lb	24,000 lb
Speed at cont. rating of traction motors ..	60 mph	49 mph



New Bo-Bo locomotive to operate on British Railways' 25 kV system

The locomotive is designed primarily for operation at a line voltage of 25 kV 50 cycles a.c. However, it has also to develop its full output at 6·25 kV because certain sections of the overhead line have limited electrical clearance under some bridges and tunnels and are fed at this reduced voltage. This is achieved by arranging the main transformer primary winding in four sections, connected in series for a 25 kV supply and in parallel for a 6·25 kV supply. This is effected automatically by an oil-immersed off-load changeover switch controlled by a voltage selector relay.

Current collected from the overhead wire by pantographs of the Stone-Faiveley AMBR pattern is fed through a Brown Boveri air blast circuit breaker mounted on the roof to the main transformer. The output of the

transformer is converted to direct current for the traction motors by three air cooled six-anode pumpless steel tank mercury arc rectifiers, diametrically connected in parallel so that each tank has three anodes in each half cycle. Load sharing reactors are provided to ensure current sharing between tanks and individual anodes. Smoothing chokes are also provided.

The four traction motors are connected permanently in parallel. They are six-pole series wound machines specially developed for operation on a rectified 50 cycles single phase supply. The motors are forced ventilated and designed for long periods of operation between overhauls. This has been achieved by using, among other things, class H insulation and special lubrication arrangements. The rating of the motors are:

Continuous rating	975V	700A	847 hp
1 HR rating	975V	760A	920 hp
Gear ratio type A	29/76		
Gear ratio type B	26/83		

The motors are fully spring borne in the bogies, the drive being transmitted to the road wheels by a quill drive developed from the Alsthom pattern.

A camshaft control unit, actuated by the driver's master controller, provides 37 accelerating notches and two field weakening notches. Voltage control is by on-load tap-changing on the low voltage side of the transformer winding and the output is fed to the rectifiers through two high speed circuit breakers, thus rendering anode fuses unnecessary. Besides giving protection against backfires, these breakers are also used as contactors during ordinary locomotive operation so that no individual motor contactors are provided.

Two traction motor blowers, three rectifier cooling fans, two transformer oil cooling radiator fans and a transformer oil circulating pump are driven by a.c. single phase capacitor start and run motors. Two exhausters and one compressor are driven by d.c. motors. One exhauster is battery fed; the other exhauster and the compressor are fed from the a.c. supply through germanium rectifiers. The battery is floating continuously on a battery charger of the magnestat type which also incorporates a germanium rectifier.

The locomotive is of the double ended type and the driving compartments at each end are connected by a corridor. Behind each driving compartment is a space in which are housed the compressor, exhausters and traction motor blowers and other equipment. The central compartment, to which access is obtained by means of an interlocked door at No. 2 end, houses the control gear, transformer and rectifiers. The interlocking allows access to the compartment only when the pantographs are lowered and the high voltage equipment is earthed.

The complete body of the locomotive is designed as weight carrying structure and consists of a fabricated underframe with side members and centre sills of rolled steel channel section. Between the bolsters, the sideframes, which are riveted to the underframe, are of braced frame construction with deep section cantrails, joined at intervals by transverse members which also carry the pantograph feet. This provides a structure combining lightness with high resistance to buffing shocks and eccentric loading. The transverse members, which also carry the roof traps, are removable so that the body of the locomotive can be completely opened at the top between the cab bulkheads if required for removal of equipment.

The cabs at either end are in accordance with the size and layout decided upon by British Railways, as the standard for this type of a.c. locomotive, and give unusually spacious and comfortable accommodation for the crew.

In order to achieve light weight, the maximum use has been made of glass-fibre construction for such items as cab roofs, doors, bulkheads, air ducts and even the transformer oil conservator tank.

The bogies are of special interest as the suspension and the flexible drive from the frame mounted motors utilize the well-known and proved Alsthom principles incorporating rubber bearing and pivots. The bogie frame is fabricated from "Corten" steel and the design is such that the welding between side frames and cross members is carried out away from the points of maximum stress.

The traction motors with their gears and quill shafts are carried on 3-point pre-loaded rubber mountings in the bogie frames and are coupled to the road wheels by Alsthom type link drives.

The wheel sets are carried in double row spherical roller Skefko bearing axle boxes which are connected to the bogie frames by rubber bushed radius arms giving a cushioned resistance to lateral impacts.

The primary coil springs are mounted on equalizing beams underslung from the axle boxes in rubber "chevron" mountings and hydraulic dampers are fitted.

Separate brake cylinders are provided for each wheel and the employment of reaction support of the inner hangers gives a very simple brake rigging. The brakes, including compressors and exhausters, were supplied by the Westinghouse Brake & Signal Company Limited.

The Alsthom type secondary suspension consists of a vertical column between the underframe and bogie fixed bolster with large rubber conical bearings at either end. Tractive effort is transmitted through the rubber, but fore and aft angular movement of the column is controlled by manganese bearing pads while side movement is controlled by pre-loaded double acting springs.

A small proportion of the body weight is taken on 4-coil support springs on each bogie via manganese steel pads.

Under small transverse accelerations, the body oscillates about the lower pivot only, but under the influence of higher forces, sufficient to overcome the pre-loaded side control springs, the body can move sideways in relation to the bogie. The combined effect is that the period of natural oscillation is governed to a large extent by the severity of the exciting force. Absence of body roll with this type of suspension is particularly noticeable.

Tube Furnace

A new tube furnace for works or laboratory has chambers ranging from 1 in. bore × 12 in. length to 2 in. bore by 18 in. length. Good insulation is provided around the coiled-coil heater winding which is cemented to the furnace tube. Heater leads and terminals are protected within the base which will accommodate any optional accessories (such as 4 in. pyrometer and energy regulator) or controller, contactor, etc. A thermocouple can be arranged to come to the outside of the winding or the tube and winding can be had with a hole to expose thermocouple tip to full chamber temperature. The split casing allows increased cooling speed if needed.

The makers, R. M. Catterson-Smith Limited, Adams Bridge Works, South Way, Exhibition Grounds, Wembley, Middlesex, have the furnace in production in ten sizes for delivery from stock. A variety of modifications is also available to suit special needs.

technique

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Automated Diode Manufacture

A largely automatic plant for the production of diodes has been put into operation by Ferranti Limited at their Gem Mill factory in Oldham, Lancs. All operations in the final assembly of the header such as flash welding the wire on the back of it, passing through hydrogen furnace to remove oxidation, are carried out by automatic transfer mechanisms. As the stages of copper and gold plating the header assembly and that of pre-soldering the dice to the header lend themselves well to batch production, no automatic mechanism is used for these processes.

The mechanism used for the assembly of the lead wire to the header is controlled from a common camshaft, the use of which enables the overall index figure, nominally eight seconds, to be varied at will. The headers, which are produced on high-speed Swiss automatic machines at another Ferranti factory in Oldham, are thoroughly washed and de-greased before they are placed into a hopper which is located at one end of the machine.

From the hopper, the headers are sorted out and presented one at a time to a magazine. An escape mechanism releases the header down an inclined chute to an indexing table where it is moved into a cup by means of an air jet. Each time the table indexes, a vacuum arm picks up a header off the table and transfers it through 180° to a second table where it accurately locates it in a Nimonic alloy jig. This table then indexes round and presents the header to the lead wire and then an oxy-coal gas flame is brought into position to make the weld. After welding, the wire is measured to length and cropped accurately by transverse guillotine knives.

The completed header is then indexed to a position where it is blown out of the jig and up through a tube in the form of an inverted U which transfers it to a small hydrogen furnace where oxide created by welding is removed. After passing through this furnace, the component is collected in a container and taken away to be copper and gold plated.

The header with solder disc and silicon dice mounted on top, and in contact with each other, are then assembled in a jig which is passed through a hydrogen furnace for a period of about 15 min. During the cooling cycle the dice adheres to the top of the header.

Post-etching treatment, which is the next stage of the process, is also carried out automatically by means of a specially designed plant. Its use has already shown a marked increase in the efficiency of the diodes. A notable feature of this plant is that dangerous etching liquors (in this case, a mixture of hydrofluoric, acetic and nitric acids) are stored remotely in a cabinet outside the area where the operator is working. A rotary indexing table passes the components through a series of etching, cleaning and drying stations before the final index position where automatic varnishing is carried out. The index position before varnishing is utilized for checking the polarity of the dice by means of a wire probe. The index figure of this mechanism is infinitely variable from five to ten seconds and the period in which the dice is exposed to the atmosphere is limited to 17 sec.

The etching liquor is constantly circulated throughout the system and on return to the sump is forced up to the header tank through an interconnecting pipe by a pressure of 3 psi being applied to the surface of the liquor. Adequate ventilation has been arranged and this is in the form of extractors fitted over the top of the remote cabinet removing dangerous fumes.

Before final encapsulation, which is carried out by an automatic machine with an indexing time of 15 sec, a solder ring is placed on the header plinth and this assembly is located in a small ceramic chuck. The can, complete with glass seal through which the lead wire and compensator pass, is located directly above the plinth, the whole assembly is then placed in a vacuum chamber.

The machine indexes round through a series of eddy current heating positions until a predetermined time has elapsed when a trip mechanism allows the can to drop on the plinth, thereby locating the compensator on top of the dice which is positioned directly below it. The table continues to index while the assembly is allowed to cool to form the hermetically sealed encapsulation.

Automated Manufacture of Rubber-bonded Suspension Units

The rubber suspension units and rubber couplings of the Morris Mini-Minor 850 and Austin Seven 850 are made in a new Dunlop factory at Coventry which uses rubber at the rate of 24,640 lb per week. The processes are highly automated and produce the parts to very fine limits.

The tolerances to which the plant for the suspension units operates are probably closer than any which have previously been obtained with large volume production of rubber-metal bonded components. For example, the K modulus of the rubber compound is held to within $\pm 5\frac{1}{4}\%$ and the height of the deflected suspension unit is kept within $\pm$ ·005 in.

The metal parts are produced on a press line, then degreased and shot-blasted. After transfer to the solutioning room, they are placed on trays and immersed in boiling trichlorethylene to remove any residue from shot-blasting and any contamination from the operatives' hands. The parts are next fed into a plant which automatically sprays the appropriate faces with the two bonding solutions and then ejects them with solutions dried.

At this stage rubber blanks which have been cut to weight from hollow cylindrical extrusions, are placed on the prepared metal surface and the assembly automatically transferred to the moulding press line. After moulding, the units are moved on a high-speed conveyor into a final curing oven, closely controlled

for temperature, through which they pass at a slow speed.

From this operation, the units are ejected on to a storage conveyor where they are matured for 24 hr. The units are automatically ejected from the maturing conveyor in the same order in which they were loaded and transferred to the bond-testing machines. The final operation is spray painting the exposed metal surfaces.

The entire sequence of manufacturing and testing operations is stringently controlled, with rejection of any units outside the narrow limits laid down.

The production plant automatically carries out a series of tests on every suspension unit made. Each unit has a bond test in tension and then passes to an automatic performance testing machine. Here the unit is first measured for overall height and then deflected three times to break down moulding stresses. This is followed by deflection tests, where a test load to within $\pm \frac{1}{4}\%$ is applied and the deflection measured; units which vary more than $\pm 2{\cdot}8\%$ from a specified deflected height are automatically rejected. In order to eliminate any initial 'creep' effect during the test, the mechanism ensures that the measurement is taken between the 28th and the 32nd second after the load has been applied.

The next process is a machining operation. After loading to the test figure, the bottom of the outer metal flange is machined so that the height of the deflected unit is within $\pm$ 0·005 in., irrespective of any variations in the rubber part. As with the previous test, in order to eliminate initial creep effects, the machining operation is completed between the 28th and the 32nd second after the load has been applied.

As a final test, a percentage of the units are rechecked for loaded height on another machine to ensure that all the previous operations have been carried out correctly.

In the production line for the coupling units, the nine metal parts are made by conventional methods on a roll-feed press, but the moulding operations are quite different. The metal parts are loaded into single cavity moulds mounted at eight stations on a rotary table, which indexes intermittently. These stations comprise unloading from the conveyor, mould opening and stripping, mould cleaning, two stations for mould re-loading, mould closing, rubber injection into the mould and transfer to the main conveyor. Seventy-five moulds are in cure at any given time.

After the moulding and curing operations, the coupling units are allowed to mature and then bond-tested in a machine which applies a torsional load to each arm in turn. The angle through which each arm should turn is known and acts as a check on the hardness of the rubber compound. The remaining operations include trimming off the rubber flash, spray painting and lettering.

Electrical Installation in a Food Factory

Flexibility is the keynote of the H. J. Heinz food factory at Kitt Green, Nr. Wigan, Lancashire.

A 6·6 kV supply from the North Western Electricity Board is taken into the intake sub-station and is distributed from there at 6·6 kV around the site by means of two separate ring mains, feeding groups of three and four sub-stations respectively. The rings are arranged to run with one leg open and protection is by means of I.T.M.D. overload and earth leakage relay.

The h.v. supply is transformed at the seven sub-stations to 415 V, three phase, 4 wire, by Class H transformers of 500 kVA capacity, the total transformer capacity, including stand-by, being 7·5 MW. Each of the transformers is protected by overload and restricted earth leakage relays with intertripping between the h.v. and m.v. switchgear. Automatic power factor correction is provided in each sub-station and the h.v. compartment is protected against fire by automatic CO_2 equipment.

In the case of the main production building containing three of the sub-stations, the m.v. supply from each sub-station is broken down into three sub-mains distribution points. The whole of the mains and sub-mains distribution is run in P.I.L.C.S.W.A. and S cable and throughout the site nine miles of this type of cable has been used. With the exception of the boiler house the whole of the final circuit distribution has been carried out in P.V.C. insulated cable, run in multi-compartment trunking and conduit. Seven hundred and ninety miles of this type of single and/or multicore cable have been used, all supplied by Crompton Parkinson Limited. In the main production building, which comprises two production floors and a service floor, the whole of the services are concealed in the building structure and mains and sub-mains run in specially constructed void between the floors. All the cable boxes, junctions and switchboxes meet the necessary food factory regulations, including watertightness.

The lighting on the production floors is semi-recessed, using two thousand six hundred, five foot twin tube, fluorescent fittings with opal Perspex diffusers which are both moisture and vermin proof. These fittings which are group contactor controlled give an average intensity of 20 lu/sq ft and are arranged to take a third tube so that this intensity may be increased in the future if required. Emergency lighting is provided automatically on mains failure throughout the whole of this building by means of separate tungsten lighting fittings fed from a battery system.

Supplies to production machinery are taken from distribution boards recessed into the tiled columns and the whole of the machine wiring, which is P.V.C. insulated, is run in watertight galvanized trunking and conduit down drops to starters, isolators and relays, etc.

Lighting in the raw materials store and warehouse is by means of open trough vitreous enamelled 5 ft twin tube, fluorescent fittings. Approximately five hundred of these fittings have been used, giving an average intensity of 8 to 10 lu/sq ft. In the can factory one hundred and sixty Crompton Parkinson stove-enamelled twin tube open reflector fittings have been used, suspended from "Lightline" trunking. This installation gives an average intensity of 20 lu/sq ft.

The boiler plant which is rated at 150,000 lb of steam per hour from three water tube boilers, is an outdoor installation with only the control room area under cover. The whole of the electrical work including the control wiring is carried out in M.I.C.C. cables on perforated steel tray. Sixteen miles of M.I.C.C. cables of varying sizes were used.

There is a system of 110 V, 3 phase, socket outlets for portable equipment throughout the site. These are connected in groups on a ring main, each ring being fed by a 10 kVA transformer and provided with earth leakage protection operating on a leakage current of 10 mA.

Design Factors for Aluminium Alloy Arc Welded Joints

The factors which must be considered in the successful butt, fillet, lap and complex welding; specifically of aluminium alloys by electric arc. Also discussed are possible defects and the main points in the inspection and testing of such welds

HIGH-STRENGTH aluminium alloys tend to crack when being welded, their mechanical properties are reduced in the heat-affected zone and the grain size of the weld metal is coarse. It was not until the advent of the inert-gas welding processes that these alloys could be satisfactorily welded. The speed of arc welding reduces the heat-affected zone and results in fine grain size in the weld metal; stresses during cooling are also reduced, minimizing distortion and eliminating the occurrence of cracks. Gas welds and metal-arc welds both suffered from corrosive flux residues which could not always be removed, thus lapped or fillet welds were not advisable and joints had to be designed as butt welds. Inert-gas welding is, however, free from this difficulty, so that the designer can choose any form of joint that is commonly used for steel.

The tensile strength of butt welds in most aluminium alloys is about the same as that of the parent metal in the soft or annealed condition, but the strength obtained by work-hardening the non-heat-treatable alloys will be less in the heat-affected zone, and heat-treated alloys suffer reduction in strength along each side of the weld. Design must necessarily be based on the weakest part—the strength of the soft material, but if welds are located at points of minimum stress, for example, along the neutral axis of members stressed as beams, heat-treated alloys can be incorporated in the welded assembly. Due to the geometry of the welded section, butt joints are better than lapped or fillet joints, and butt welds give more uniform stress distribution than fillet welds.

Both fillet and lap welds result in concentration of stress, and although they should be loaded only in shear, various combinations of tension and bending always occur in practice; thus they should not be used for the same high stresses as are butt welds. The tensile properties of butt welds are shown in Tables I and II, proof stress figures being omitted because a satisfactory gauge length cannot be chosen to give figures that have any practical value. There is little information so far available on the strength of fillet welds, but when they are designed to carry shear stress the ultimate shear stress of the materials concerned can be taken as a guide. Table III shows the differences between transverse and longitudinal shear strengths of fillet welds.

Complex shapes are readily produced by extrusion, allowing the designer to locate metal where it will be most effective in providing stiffness and/or strength; sections can also be designed so that bevels are included in the "as extruded" section of the metal required for a welded assembly. Special sections—especially T-sections—can be used as backing bars for making butt joints in the plating of aluminium structures such as parts of ships, and the designer should also bear in mind the development of integrally stiffened sections such as the barge plate sections produced for the building of welded aluminium alloy barges. As with all metals, abrupt changes of section should be avoided, or at least made as gradual as possible. The welds should be able to be made without excessive build-up or spatter. If assemblies are designed with stiffeners welded to plate metal, the intermittent welding of the stiffeners could leave crevices, giving rise to corrosion. It is often quicker and cheaper with the inert-gas arc processes, to lay down continuous runs of small fillet welds than to make large fillets intermittently.

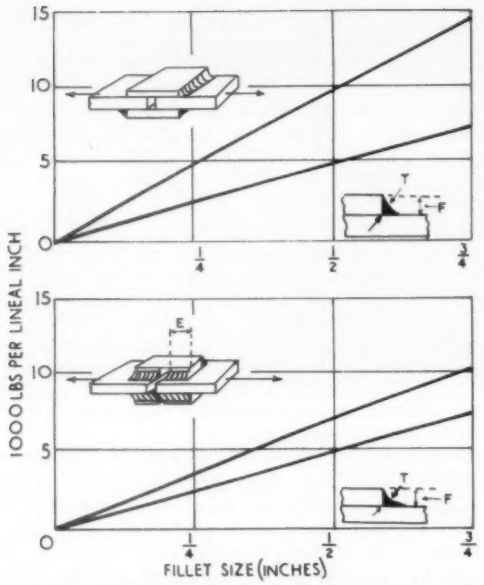
With the modern metal-arc and inert gas shielded-arc processes, welding is now practicable for structural elements in shipbuilding, civil engineering and building, the welds being made between plate, sheet, sections and tubes; they are also used for joining dissimilar metals and wrought to cast metals. Development of recent processes and techniques have considerably improved the geometry of the joints. If fillet welds and lapped joints are required in the design, the argon-arc or inert gas metal-arc processes should be used. Further improvements in materials and techniques are enabling welding to be used for the higher strength alloys and to more highly-stressed assemblies.

The main defects occurring in arc welds are lack of

Table I.—AVERAGE MECHANICAL PROPERTIES OF BUTT-WELDED WROUGHT ALUMINIUM ALLOYS

B.S. 1470–1477	Processes	Filler Rods	U.T.S. Tons per sq in. U.	W.	R.	Elongation % on 2 in. U.	W.	R.
Work-hardenable Materials: Aluminium								
1A–O	AI	1A 1B	3·5	3–5	n.a.	35	15–5	n.a.
–½H	,,	,, ,,	6·0	3–5	,,	8	,,	,,
1B–O	,,	1B	4·0	4–5	,,	30	,,	,,
–½H	,,	,,	6·5	,,	,,	8	,,	,,
1C–O	MAI	1C 1B	4·0	4–5	,,	30	,,	,,
–½H	,,	,, ,,	7·0	,,	,,	7	,,	,,
Alloys: N3–O	MAI	N3 1B	7·0	6–7	n.a.	30	15–5	n.a.
–½H	,,	,, ,,	10·5	,,	,,	5	,,	,,
N4–O	AI	N5 N6	11·0	8–9	,,	18	10–5	,,
–½H	,,	,, ,,	15·0	,,	,,	5	,,	,,
N5–O	,,	N6	14·0	12–16	,,	18	,,	,,
½H	,,	,,	17·0	,,	,,	8	,,	,,
N5/6–M	A	,,	17·0	15–19	,,	12	—	,,
N6–O	,,	,,	17·0	,,	,,	18	10–5	,,
–½H	,,	,,	19·0	,,	,,	8	,,	,,
Heat-treatable Alloys: H9–W	MAI	N21 N6 H10	9·0	6–7	7–9	18	15–10	18–10
–WP	,,	,, ,, ,,	12·0	7–12	10–15	12	12–10	10–5
H10–W	AI	,, ,, ,,	12·0	10–14	10–15	18	,,	18–10
–WP	MAI	,, ,, ,,	18·0	16–19	16–20	18–7	,,	10–5
H20–W	,,	,, ,, ,,	12·0	10–14	10–15	18	,,	18–10
–WP	,,	,, ,, ,,	18·0	,,	16–19	10	,,	,,
H30–W	,,	,, ,, ,,	12·0	,,	10–15	18	,,	,,
–WP	,,	,, ,, ,,	19·0	16–19	16–20	10	,,	10–5
H14–T	A	N21 or spcl. alloy	24·0	,,	15–25	12	10–5	7–3
H15–WP	,,	N21 or spcl. alloy	26·0	20–28	20–30	15	,,	,,

Notes: Processes: Only the best for each metal are indicated: M, metal arc; A, argon arc; I, inert gas metal arc. The argon arc process is suitable for all. The U.T.S. and elongation given are typical mechanical properties of parent metal and of sound welds. U, unwelded; W, as welded; R, re-heat-treated.



Transverse (above) and longitudinal strengths of fillet welds in relation to weld size. (Derived from "Welding Alcoa Aluminium" and applied to related British alloys). (E = 1½ in.; ends of weld machined. T, Throat depth. F, Fillet size)

fusion, presence of oxide films within the weld, cracks, porosity and tungsten inclusions, all of which, with other defects, are described in B.S. 499, Sect. 6. Whether any particular defect can be tolerated or not, and if so to what extent, depends on the type of assembly and service conditions. The main factors are usually the extent to which the joint will be stressed in service, and the finish required.

Inspecting or testing such welds should consist of visual examination of surface and weld (including, if possible, cross-section), X-ray examination, mechanical tests, and special tests such as pressure tests of the completed work. Visual inspection is generally good enough to show that insufficient metal has been added or that the weld bead is irregular, and also to determine the presence of any cracks, surface porosity, undercut or reduction in thickness of the parent metal caused by

Tab'e II.—AVERAGE MECHANICAL PROPERTIES OF WELDED CAST ALUMINIUM ALLOYS

B.S. 1490	Processes		Filler Rod	U.T.S.			Elongation	
	M	A		U.	W.	R	U.	W.
				Tons per sq in.			% on 2 in.	
LM1	F	G	5% Cu	8–10	7–8	n.a.	—	—
LM2	G	G	N2	8–9½	8–9	,,	—	—
LM3	N	F	5% Cu	9·	,,	,,	—	—
LM4	F	G	N2, N21	9–10	9–10	,,	2	2–1
LM5	F	G	5–7% Mg	9–11	9–11	,,	5–3	3–2
LM6	G	G	N2	10½–12	10–12	,,	7–5	5–3
LM8	F	F	N21, N2 or Special	11–17	9–10	10–16	5–2½	3–2
LM9	F	F	Special	11–19	10–12	10–18	2–1½	2–1
LM11	F	F	5% Cu	14–20	12–14	12–18	13–7	—

Notes: Processes: G, good; F, fair; N, not recommended. U.T.S. and elongation as for Table I. M, metal arc; A, argon arc.

Table III.— SHEAR STRENGTH OF FILLET WELDS

Aluminium Alloy		Average Shear Strength	
Parent Metal	Filler Metal	Longitudinal	Transverse
		Tons per sq in.	
1C	1C	5·5	6·5
N3	1C	,,	,,
N4	N4	,,	9·5
N5	N5	10·5	13·5
H20-WP	N21	8·0	10·0

welding. Microscopic examination of polished cross-sections will show any lack of fusion, cracks, porosity or inclusions.

X-ray examination reveals all the defects mentioned above as well as other types of non-uniformity in the weld structure; B.S. 499 contains examples of radiographs. Mechanical tests include the usual tensile testing of either the actual joint, or of a test joint, to destruction, made under identical conditions, the examination of tensile fracture in the case of failure at weld, and bend tests—which give an indication of the ductility of the joint and are carried out substantially as in B.S. 1295. The ultrasonic flaw detection method is a form of non-destructive testing commonly applied to light alloy butt welds, particularly useful for determining cracks and discontinuities. Crack detection inks and dye penetrants are also available for use when radiographic equipment is not available.

Dissolved Oxygen Recorder

Modern high temperature and high pressure steam systems need dissolved oxygen recorders that are capable of measuring concentrations of less than 0·01 parts per million of dissolved oxygen in feed water to a very high degree of accuracy. Determination of such minute quantities under industrial conditions presents problems widely different from those associated with normal analysis techniques.

Chemical tests are difficult to apply, require considerable skill, and are subject to errors caused by traces of interfering substances. The sensitivity obtainable is high, but it is often very difficult to assess the magnitude of these errors. The method is discontinuous and depends to a great extent on the ability of the analyst.

This instrument uses an indifferent gas, hydrogen, to transfer the dissolved oxygen physically from the feed water to an electro-chemical measuring cell that is specific for oxygen. The gas transfer system separates the oxygen from non-volatile impurities in the feed water which may cause serious errors of measurement. Volatile impurities, such as sulphite, hydrazine, cyclohexylamine, etc., do not affect the measurement. Another outstanding advantage is that the transfer system, by its very nature, enables simple and very precise determination of zero and sensitivity to be made.

In the gas transfer system, virtually the same hydrogen is circulated continuously through the feed water sample removing oxygen from solution until the concentration of oxygen in hydrogen (gas phase) is in equilibrium with that dissolved in the water (liquid phase). When this state of equilibrium is reached, the concentration of oxygen in the hydrogen and the concentration of oxygen dissolved in the feed water are related to each other by the well-known laws of solubility of gases.

The electro-chemical cell, which consists of an electrode system immersed in an electrolyte, produces a current proportional to the concentration of oxygen in the hydrogen. The current is measured by a self-balancing potentiometric recorder calibrated normally in parts per million dissolved oygen in water.

The only assumption made is that the laws of solubility of oxygen are valid at low concentrations. This has been exhaustively tested on many occasions with water from many different sources. In no case has any significant error been found.

A Rotasembler unit in use. The operator is taking a component from one of the 38 hoppers while inserting a second component into a printed circuit radio receiver chassis. Each component is taken from exactly the same position and in the correct assembly sequence

Rotary Storage and Dispensing Machine for Small Components

A new rotary storage and dispensing machine known as the Rotasembler developed and manufactured by Work Study Equipments, 4 Montalt Road, Woodford Green, Essex, has made its first appearance at Regentone Radio & Television Limited, Romford, Essex. This rotary indexing machine stores large quantities of small components and dispenses them in correct assembly sequence to a point only a few inches from the assembly area. It eliminates complicated identification of parts by the operator and greatly reduces the amount of space required to store quantities of many types of components. The indexing mechanism is compressed air operated by Maxam pneumatic control equipment manufactured by Maxam Power Limited, one of the companies of the Holman Group, Camborne, Cornwall.

At present twenty Rotasemblers are in use at Regentone where they are required to store and dispense small electrical components such as resistors and capacitors used in the production of printed circuit radio and television receivers. These units replace fixed part layouts of bins arranged around the operators and they have already resulted in considerable labour and space savings, and in a 40% efficiency improvement in the assembly section where they are in use.

Despite its extremely compact appearance (28 in. circumference and 26 in. high) the Rotasembler is capable of storing up to 38 different components in 19 vertically divided hopper units. Each of these 38 hoppers can store as many as 2000 small components. The hoppers are mounted on two support rings attached to a centre shaft which is driven by a simple indexing mechanism. This mechanism comprises a chain-driven ratchet gear operated by a Maxam 1½ in. bore, 2 in. stroke double-acting air cylinder and a small brake assembly. A Maxam foot valve controls the movements of the air cylinder and brake which in turn controls the indexing movements of the hopper.

Each storage hopper unit is constructed in thin steel sheet with an enamel hammer finish and is divided vertically to provide two hoppers. The dimensions of the outside hopper are 1½ in. deep, 3 in. wide and 20 in. high. The inside hopper is 1¼ in. deep, 3 in. wide and 24 in. high. The feed lip of the outside hopper is located above the feed lip of the inside hopper and both are fitted with an adjustable gate which controls the flow of components to the feed lips. The dividing plate between each hopper protrudes above the level of the top of the double hopper unit to facilitate easy filling and to provide space for identification of the rear components. The hoppers are easily removable and allow ease of access to the indexing mechanism which is located within the circle of hoppers.

The Rotasembler unit is carried on a Y-shaped mounting plate which is bolted to the assembly area at three points. In the centre of the Y-plate is a rigid support shaft located on a mounting block reinforced by steel buttresses. Over this shaft is placed a hollow drive shaft with a bearing journal at the upper end and the indexing mechanism attached to the lower end. Two sets of three spokes radiate from the drive shaft and these are attached at their outer ends to two support rings which carry the 19 removable hopper units.

The indexing mechanism comprises a ratchet gear wheel and a fixed gear wheel attached to the drive shaft. The ratchet gear is driven by a short chain which is attached at one end to the centre of a pivoted lever and at the other end by a spring attached to a raised peg on the Y-plate. The pivoted lever is moved by the piston of the trunnion-mounted air cylinder which is normally in the extended position. When the foot operated valve is depressed by the assembly operator, compressed air passes to the forward end of the air cylinder causing the piston to retract which in turn moves the lever and chain. During this movement, the chain is drawn past the ratchet gear which is in the disengaged position and the spring on the end of the chain takes up the chain slack.

On releasing the foot valve, air passes to the mounting end of the cylinder and forces the piston outward thus moving the lever away from the ratchet gear. This causes the chain to be drawn past the gear which is now in the engaged position and turns the drive shaft and hoppers through approximately 19°.

A braking system mounted on one member of the Y-plate is brought into operation simultaneously with the movement of the hoppers which gently stops the rotation, preventing over-riding and shock to the machine. The brake is controlled by a cable attached to the pivoted lever which keeps the brake on in the resting position. When the lever is moved by the air cylinder on operation of the foot valve, the brake cable is relaxed and so releases the brake. The brake shaft is driven by a loop of chain around a gear on the brake shaft and the second fixed gear mounted above the ratchet gear on the drive shaft.

As the cylinder piston extends on release of the foot valve the lever, as already described, moves outwards. This movement causes the chain to turn the ratchet gear and drive shaft, and fixed gear which in turn drives the brake shaft. This movement also tightens the brake cable and progressively brings the brake into operation.

Transistorized Temperature Controller

The first of the new Fielden "Bikini" range of transistorized instruments is a precision temperature controller with a differential of only 0·5° C, high calibration accuracy and very high long term stability. The instrument is housed in a small meter type case and occupies a panel space 4½ in. dia. The scale, which is 9 in. long, is calibrated directly in degrees and the bold pointer is set

Three Bikini precision temperature controllers mounted on the sloping face of a control panel

to the required control temperature by a small knob in the centre of the instrument. A red lamp visible from the sides as well as from the front indicates the control action. The meter type case is completely sealed and contains no galvos, pivots or other delicate moving parts and the instrument can be mounted at any angle, for example, on a sloping control desk. Control can be at any temperature between −200° C and +500° C with a minimum temperature range span of 50° C and there are 12 standard calibrations in Centigrade and Fahrenheit.

A platinum resistance element is used at the temperature measuring point, this being housed in a robust stainless steel sheath ¼ in. dia. Ordinary connecting cable is used between the measuring point and the instrument and this can be up to 300 ft long without introducing errors. The control action is on/off, either electrical or pneumatic. The electrical contacts give changeover switching at 5 amp 250 V whilst the pneumatic valve requires 17 to 20 psi input. An interesting feature is that the electrical or pneumatic control relay can be located up to 300 ft away from the instrument itself and only simple light duty cabling is required between the instrument and the electrical or pneumatic relay.

The electronic circuit is of an advanced design and is the result of three years intensive work at the Fielden Research Laboratories, Bangor. The instrument is completely transistorized and will operate from a 12 volt d.c. supply, the components working well below their maximum rating. Practically no heat is generated and, of course, there is no "warming up" time. The low voltage and current allow handling of the instruments without fear of electrical shock and they can be used safely in hazardous areas: an Intrinsic Safety Certificate is pending. Only light duty cabling is required between the instrument and its power supply.

Fielden Electronics Limited, Paston Road, Wythenshawe, Manchester 22.

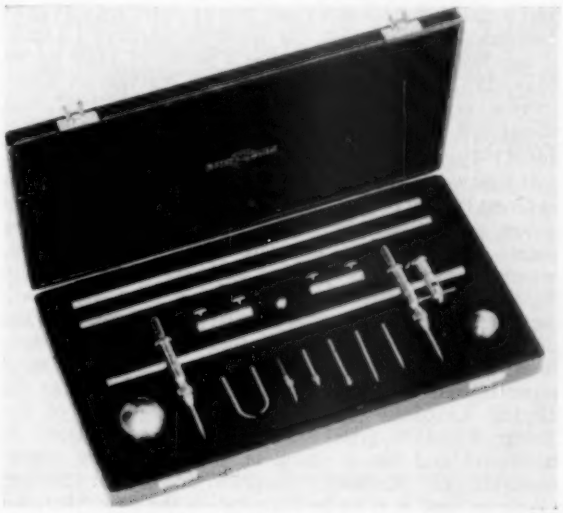
Reverse Flow Multi-cell Cyclone Dust Collector

A recent addition to the range of dust collection and control plant manufactured by the Gas Cleaning Division of W. C. Holmes & Co. Limited is the Type 'UK' reverse flow Holmes-Rothemuhle multi-cell cyclone dust collector. This collector has a higher collection efficiency than the Type RM through-pass collector which was introduced into the United Kingdom in 1957, and is particularly suitable for those applications where good gas distribution conditions cannot economically be achieved and where large gas volumes are encountered.

The collector comprises an assembly of cyclone cells, the number of which is directly proportional to the volume of gas to be cleaned. Each cyclone cell consists of two concentric tubes: an outer dirty gas cylinder with a stationary impeller fixed at the inlet and an inner clean gas tube which passes up through the centre of the impeller. The outer cylinder is approximately 10 in. dia except at the base which is conical in shape. The high separating efficiency of the collector is derived from the relatively small diameter of the individual cyclone cells.

The individual cells are supported in a sheet steel grid which is in turn enclosed in a rectangular steel casing, the lower half of which serves as the dust bunker. In the upper half of the casing or top box, the clean gas tubes terminate in a stepped floor, the construction of which facilitates the removal of individual cells for inspection and maintenance. To ensure that entering dirty gas does not by-pass the cells, gas tight joints are made on the supporting grid with a special sealing compound.

In operation, the impeller imparts an intense swirl to the dust laden gas as it enters the cell causing it to descend with a spiral motion. Near the apex of the conical section of the dirty gas cylinder the axial velocity of the spiraling gas is turned through 180°. The dust-free gas having reversed direction, passes up through the clean gas tube to the exhaust fan and stack. The dust is propelled downwards into the bunker.



The largest of three new Moore & Wright trammel sets is for diameters up to 69 in.

Stainless Steel Beam Trammels

A new trammel in three comprehensive sets of components has been produced by Moore & Wright (Sheffield) Limited, Handsworth Road, Sheffield 13. Made in stainless steel, the three sets range from a 21-in. dia adjustable trammel with 12-in. beam and scriber and caliper points in a wooden box, to a 69-in. dia similarly adjustable trammel with three-part beam and couplings, and with needle and adaptor points as well as scriber and caliper points, a set of ball ends for holes up to 1½ in. dia and a pencil chuck, the whole in a velvet-lined leather covered case. The intermediate set is boxed like the last but has the one 12-in. beam like the first.

The Marine Sphere of Application for Nuclear Energy

The large modern ocean going vessel and its power plant

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

1. Modern marine power plants

The propulsion units installed in merchant ships are:

(a) Water-tube boiler and steam turbine
(b) Diesel engine
(c) Open-cycle gas turbine
(d) Free-piston gas generator and gas turbine.

The open-cycle gas turbine for the propulsion of merchant ships has been applied only to the British vessel *Auris* and the American *John Sergeant*. The plants were installed in 1951 and 1956 respectively, the Shell tanker *Auris* had originally a 1,200 hp gas turbine which supplied approximately 25% of the total propulsion power. It is now being replaced by a 5,500 hp set. The *John Sergeant* had a maximum rating of 6,600 hp.

The first British vessel to be equipped with a propulsion plant consisting of a free-piston gas generator and a gas turbine was an ore carrier, built by Lithgows Limited, Port Glasgow, for Scottish Carriers Limited. It was installed in 1956 and has a power of 3,000 hp. In May, 1957, the British India Steam Navigation Company's vessel *Ormara* of 5444 tons, built in 1947, was re-engined with a similar plant as above but of 4,000 shp.

It follows that there are only three marine applications in Great Britain of cases (c) and (d) and that the maximum power was 6,600 hp. Consequently nuclear power plants have only to compete technically and commercially with the propulsion units (a) and (b). Up to 20,000 shp the turbo-supercharged marine diesel will prove to be the keenest competitor, particularly from the point of view of thermal performance and overall cost. It is of special interest to add that recently the most powerful turbo-charged diesel engine was tested in the United Kingdom. This 12 cylinder engine is of the Sulzer RSAD76 type, is designed for operation on boiler oil and has a rating at 15,400 shp. Its manufacturers are Alexander Stephen and Sons Limited, Glasgow, and it is to be installed in the new Ellerman ship *City of Melbourne*. It is claimed that this engine may well be the power unit for future super-tankers. Propulsion by a single-screw, driven by a diesel engine, is considered to be the most economical form of marine propulsion. It has been said that until engines of such size were developed, super tankers could be powered only by steam turbines driving a single screw, or by twin-screw diesel machinery.

Before deciding definitely on the most suitable propulsion plant the shipowner has to bear in mind the specific duty of the ship. One of the essential requirements is to prepare a detailed analysis of the various costs of the plant. On the basis of such a comparison he is then in a position to select the most economical plant. The total cost, expressed, for instance, in terms of shaft horsepower, must include the fuel charge, the capital, the maintenance and the operating costs.

2. Nuclear-powered submarine oil tankers

In September, 1957, Mitchell Engineering Limited announced that they had been exploring for some months the possibilities of large nuclear submarine oil tankers up to 100,000 tons. At the time, they revealed that special arrangements had been made with Saunders-Roe Limited to conduct in their experimental tank at Cowes a series of hydrostatic test on eight different models, representing different shapes of hull. The main objective was to determine primarily the resistance of the models when towed in water and thus the most economic shape of hull. Most of the power required for propelling a surface vessel is due to surface waves, whereas at some distance below the surface of the water the power required is less. Only experiment can indicate the amount of reduction in power at various depths and speeds. The results of these investigations were presented in a series of graphs in a recent "Leonardo da Vinci" lecture on "Transport On and Under the Sea", by Mr. W. A. Crago, Superintendent of Experimental Tank, Saunders Roe Limited. The graphs show the resistance at various speeds for surface ships and submarines of 80,000 tons displacement and indicate that, for instance, at 25 knots the resistance of a surface vessel of 1,000 ft length is about 16·4% greater than that of a submarine of the same displacement.

McCarty was the first to direct attention to the submarine tanker in his paper, "The Practicability of the Large Submarine Tanker", presented in 1955 to the Society of Naval Architects and Marine Engineers, in the United States.

3. Atlantic passenger liners

The chairman of the Cunard Steam Ship Company Limited at the annual meeting on May 28, 1959, said that detailed attention is being directed to the preparation of plans for two new passenger liners to replace the S.S. *Queen Mary* and the S.S. *Queen Elizabeth*. The specification is being considered by John Brown Limited, Clydebank, the shipbuilders of the two Queens.

These new liners are to be specially designed to compete with the S.S. *United States* which made her first Atlantic crossing on July 3, 1952. She is owned by the United States Lines and has a gross tonnage of 53,350 tons. She was the first American steamship to establish a transatlantic record after an interval of exactly a century, for in July, 1952 she won the blue riband of the Atlantic from the *Queen Mary*, who held it in 1936 and from 1938 to 1952. America's previous record was for a very short period only in 1852 and was achieved by the S.S. *Baltic* (2,264 tons) at an average speed of 13 knots.

The new British Atlantic liners are to have a gross tonnage of 80,000, which is larger than had been

expected, particularly from the point of view of overall economy in capital expenditure and operating cost. Consequently they are to be only slightly smaller than the S.S. *Queen Mary* and the S.S. *Queen Elizabeth* 81,237 and 83,673 tons respectively. The design speed of these new vessels is to be increased from the 29 knots of the Queens to 30 knots, and the passengers to be carried are to number about 2,000 instead of 2,139 and 2,283. Therefore the two new vessels will be able to maintain the same weekly service across the Atlantic as at present. It is of interest to add that more than double the passengers of any other Atlantic liner have been carried by the Queens since they began their commercial service together in 1947.

The draught of the new vessel is to be 9 ft less than that of the Queens, so that the new liners will be able to enter and leave Southampton without waiting for the tide as at present. Nuclear propulsion will not be used on the first of the new vessels but it might be applied to the second, which is to be in service some years later, if it proves to be economically justified. The estimated cost of each vessel is approximately £30 million.

The American Government placed the contract for building the S.S. *United States* in 1950 at a cost of $70 million (£26 million) and sold her in 1952 to the United States Lines for $28 million (£11·5 million). Now they propose to build a sister ship at an approximate cost of $110 million (£40 million) and have agreed to sell her to the shipping company for $45 million (£16·6 million). Therefore the selling price is 40% of the actual cost of the transaction in 1952 and 41% in 1959. These percentages correspond to a Government subsidy of 60% and 59% respectively.

Similarly, the French Government are subsidizing the building of the Atlantic liner S.S. *France* to replace the *Liberté* (51,840 tons). The Italian Government is seriously considering building a liner with the aid of a subsidy.

4. Large atlantic liners in service (1935-1959)

A summary of the essential information of the four principal liners in service in the Atlantic during the period 1935 to 1959 is presented in Table I, which indicates these in the order of the date of their maiden voyage. A brief chronological account and the significant characteristic features of these liners are given below:

(a) *S.S. Normandie.*—The keel of this originally French liner was laid only a month after that of the S.S. *Queen Mary*, on January 26, 1931. Her first Atlantic crossing was made on May 29, 1935, i.e. four years and four months later. She had a gross tonnage of 83,400 and an overall length of 1,027 ft. Both these values exceed only slightly those of the S.S. *Queen Mary* with 81,237 tons and 1,020 ft.

An outstanding feature was her turbo-electric propulsion system which had hitherto only been applied to vessels up to 20,000 tons and 20 knots. All the other liners in Table I have geared turbines. On her acceptance trials the speed was 32·15 knots and on her maiden voyage she broke the record of the S.S. *Bremen* in both directions, thus gaining the blue riband. Her early success demonstrated the advantages of turbo-electric propulsion. Records indicate that on her first six round voyages the S.S. *Normandie* maintained an average speed of 28·3 knots and for the eighteen voyages in 1937 the figure was 28·87 knots. The S.S. *Normandie* replaced the S.S. *France* of 1912.

On the day the second World War was declared both the S.S. *Normandie* and the S.S. *Queen Mary* were fortunately in New York. On December 12, 1941, the United States seized the S.S. *Normandie*, removed her officers and crew, and commenced without delay to convert her to the troopship S.S. *Lafayette*, to carry 12,000 men. Unfortunately, on February 9, 1942, whilst the modifications were in progress, a spark from a blow-lamp set some mattresses on fire and within a very short time the complete deck was ablaze. Eventually she capsized and sank. Twenty months later the Americans raised the hull at a cost of 4·5 million dollars (£1·67 million): Then it was realized that the expenditure for her reconstruction was not justified. Finally she was sold in September, 1946, and towed to a shipbreaking yard at Port Newark, New Jersey, eleven years after her maiden voyage. During this period she was only

Table I.—A SUMMARY OF THE ESSENTIAL PARTICULARS OF LARGE ATLANTIC PASSENGER LINERS (1935–1959)

1	2	3	4	5	6	7
	Atlantic liner	Unit	*Normandie* (1935–1941) *Lafayette* (1941–1946)	*Queen Mary* (1936–)	*Queen Elizabeth* (1940–)	*United States* (1952–)
	Shipbuilder		Ch. et Atelier de St. Nazaire	John Brown Ltd. Clydebank	John Brown Ltd.	Newport News Shipbuilding
Item	Owners		Cie Generale Trans-atlantique (1935–1941) U.S. Navy (1941–1946)	Cunard White Star Line	Cunard White Star Line	United States Lines
1	Keel laid	—	26.1.1931	27.12.1930	4.12.1936	8.2.1950
2	Construction suspended	—	—	10.12.1931	—	—
3	Construction resumed	—	—	April 1934	—	—
4	Launching	—	29.10.1932	16.9.1934	27.9.1938	23.6.1951
5	First trials	—	—	26.3.1936	—	—
6	First Atlantic crossing	—	29.5.1935	27.5.1936	27.2.1940	3.7.1952
7	Maiden commercial voyage	—	29.5.1935	27.5.1936	25.10.1946	3.7.1952
8	Gross tonnage	ton	83,400	81,237	83,673	53,350
9	Overall length	ft	1027	1020	1031	990
10	Length	ft	963	975	982	950
11	Beam	ft	119	118	118	101
12	Height	ft	91	69	—	—
13	Draught	ft	36·7	38·1	39	—
14	Design speed	kn	31	29	29	34
15	Total power at design speed	shp	160,000	158,000	160,000	158,000
16	Number of propellers	—	4	4	4	4
17	Number of funnels	—	3	3	2	2
18	Type of propulsion machinery	—	turbo-electric	geared turbines	geared turbines	geared turbines
19	Number of turbines	—	—	16	—	—
20	Number of boilers	—	—	24	12	—
21	Passengers: first class	—	848	776	823	882
	Cabin	—	670	784	662	525
	Tourist	—	454	579	798	555
	Total	—	1972	2139	2283	1962
22	Crew	—	1350	1100	1200	—

on active service for approximately 4½ years. Thus ended tragically the existence of a world-famous Atlantic liner.

(b) *S.S. Queen Mary.*—The construction of this Cunard White Star Atlantic liner was commenced during one of the worst depression periods that shipping has ever known. The keel was laid on December 27, 1930. For financial reasons the construction had to be suspended after a year. However, in April, 1934, the work was resumed and her first Atlantic crossing was on May 27, 1936, five years and five months after laying the keel. Her maiden voyage was exactly, within two days, a year later than the S.S. *Normandie*.

No attempt had been made by the S.S. *Queen Mary* to beat the record of the S.S. *Normandie* until her sixth voyage which proved so successful that in 1936 she gained the Blue Riband. In 1937 the French liner recovered the honour, but lost it again in the following year. Thus the S.S. *Queen Mary* retained this record for about four years until it was passed on to the S.S. *United States* on her maiden voyage on July 3, 1952. The record-breaking performance of the latter was really remarkable, for the time to cross the Atlantic from Bishop Rock to Ambrose Light was reduced by 9 hr 36 min, and in the reverse direction by 10 hr 2 min. The average speeds were 34·51 and 35·59 knots respectively. The corresponding values for the S.S. *Queen Mary* on her last record voyage in 1938 were 30·99 and 31·69 knots. During the war the S.S. *Queen Mary* made 86 Atlantic crossings. On July 31, 1947, she re-entered the Cunard Atlantic service, the revised gross tonnage being now 81,237. Her best post-war voyage is 4 days 15 hr from Southampton to New York, the average speed being 28·44 knots.

(c) *S.S. Queen Elizabeth.*—The hull and the machinery resemble those of her sister ship. However, a number of technical improvements have been incorporated. The number of boilers is reduced from 24 to 12. This had the desired advantage of eliminating one of the three funnels. The keel was laid on December 4, 1936 and she was launched on September 27, 1938, at a critical time when preparations were being made for war. Before her completion she made the first and secret dash across the Atlantic, leaving the Clyde on February 27, 1940 and reaching New York via Southampton nine days later. She joined the S.S. *Normandie* and S.S. *Queen Mary*.

She was converted into a troopship by the Singapore Naval Dock Yard. After being modified on the Clyde and at Southampton she began on October 25, 1946, her first commercial voyage across the Atlantic.

The S.S. *Queen Elizabeth* is the largest passenger vessel in the world for she has a gross tonnage of 83,673, an overall length of 1,031 ft, a beam of 118 ft, a draught of 39 ft and a total shaft power of 160,000. There are four groups of turbines, each driving a propeller through single reduction gearing. Each group consists of four turbines, H.P., first I.P., second I.P. and L.P. Each of these drives a separate pinion which engages with the main slow speed wheel coupled to the propeller shaft. The gearing is double-helical with involute teeth. There are 12 Yarrow-type water tube boilers, producing steam at 425 psig and 750° F. The cross-section of each of the two funnels is 44 ft by 30 ft and the forward funnel is over 70 ft above the sun deck. Each of the four bladed propellers weighs 32 tons.

(d) *S.S. United States.*—The keel of this ship was laid on February 8, 1950, and her maiden voyage across the Atlantic was made on July 3, 1952, therefore the construction period for the complete liner was remarkably short, only 2 years and 5 months. She is the flagship of the United States Lines and is the largest passenger vessel built in America and the third in the world. She has a gross tonnage of 53,350, an overall length of 990 ft, a beam of only 101 ft, a total shaft power of 158,000 and a design speed of 34 knots. She was designed originally as a troopship and the contract was placed by the United States Navy. A specified condition was that she should be able to pass through the Panama Canal, therefore her beam had to be limited to 101 ft which had the effect of producing a more slender vessel. The ratio of beam to overall length is 0·1021; on the S.S. *Queen Elizabeth* this value is increased to 0·1145, generally used for Atlantic liners.

A notable feature of her superstructure is that over a length of 600 ft it has been constructed of aluminium alloy. In addition, exceptional precautions against fire were taken in the design and the selection of the materials. Since her maiden voyage she has retained the Blue Riband and, consequently, is the fastest passenger vessel in the world. Her record-breaking average speed across the Atlantic from Ambrose Light to Bishop Rock in 1952 was 35·59 knots and the time taken between these two points was 3 days 10 hr 40 min.

The propulsion machinery consist of four sets of geared turbines, two of which drive five-bladed and the other two four-bladed propellers. Additional design data and particulars are presented in Table I.

(e) *A comparison of the essential particulars of large Atlantic liners.*—Information on the S.S. *Normandie*, S.S. *Queen Mary*, S.S. *Queen Elizabeth* and S.S. *United States*, the four largest liners in the world, is summarized in Table I. Their impressive technical achievements, remarkable reliability in service and excellent operating performance have received international recognition. Consequently it is of particular interest to direct attention to certain characteristic features. A closer examination of the data reveals:

(1) The gross tonnage of the three largest liners is about the same, varying between 81,237 to 83,673, whilst the S.S. *United States* is only 53,350
(2) The overall length of the three largest vessels varies from 1,020 ft for the S.S. *Queen Mary* to 1,031 ft for the S.S. *Queen Elizabeth*, the S.S. *Normandie* being 1,027 ft. The S.S. *United States* is only 990 ft
(3) The beam of the three largest liners measures 119, 118 and 118 ft respectively, the first refers to the S.S. *Normandie* which is only one foot larger than the Queens. The beam of the S.S. *United States* is only 101 ft
(4) The design speed varies from 29 to 31 knots for the larger and 34 knots for the smaller vessels
(5) The total shaft horse power of each of the four vessels is practically the same, the variation being from 158,000 to 160,000
(6) Each vessel has four propellers

Table II.—PASSENGER LINERS WHICH GAINED THE "BLUE RIBAND OF THE ATLANTIC" (1935 to 1959)

1	2	3			4	5	6			7
	Bishop Rock to Ambrose					Ambrose to Bishop Rock				
Year	Liner	Time			Speed	Liner	Time			Speed
		d	h	m	kn		d	h	m	kn
1935	*Normandie*	4	3	14	29·94	*Normandie*	4	3	28	30·31
1936	*Queen Mary*	4	0	27	30·14	*Queen Mary*	3	23	57	30·63
1937	*Normandie*	3	23	2	30·58	*Normandie*	3	22	7	31·20
1938	*Queen Mary*	3	21	48	30·99	*Queen Mary*	2	20	42	31·69
1952	*United States*	3	12	12	34·51	*United States*	3	10	40	35·59

Table III.—NEW ATLANTIC LINERS

1	2	3	4	5	6	7
	Country	Number of vessel	Name of vessel	Gross tonnage	Length	Speed
				ton	ft	kn
1	Great Britain	2		80,000		30·0
2	France	1	S.S. *France*	55,000/60,000	1,041	31·0
3	Holland	1	† S.S. *Rotterdam*	38,650	650	20·5
4	Germany	1	* S.S. *Bremen*	32,000		
5	Italy	1				
6	United States	1		53,000		

† Maiden voyage to New York on September 3rd 1959 (see table V)

* Maiden voyage to New York on July 12th 1959

Table IV.—PARTICULARS OF ATLANTIC LINERS IN SERVICE TO BE REPLACED IN THE NEAR FUTURE

1	2	3	4	5	6
	Atlantic liner		*Liberté* (*Ex-Europa*) (1946–)	*Nieuw Amsterdam* (1938–)	*America* (1946–)
	Owners		Cie Gen. Transatlantique	Holland-America Line	United States Lines
1	Date of first commercial service across the Atlantic	—	17.8.1950	10.5.1938	14.11.1946
2	Gross tonnage	ton	51,840	36,667	33,550
3	Length	ft	936	713	661
4	Beam	ft	100	88	93
5	Service speed	kn	26·5	21·5	22·5
6	Number of propellers	—	4	2	2
7	Number of funnels	—	2	2	2
8	Number of passengers	—	1531	1207	

Table V.—PARTICULARS OF THE S.S. ROTTERDAM OF THE HOLLAND-AMERICA LINE

1	Builders	Rotterdam Drydock Company
2	Engined by	N. V. Koninklijke Maatschappij "De Schelde"
3	Date of maiden voyage to New York	September 3, 1959
4	Vessel:	
	(a) length	650 ft
	(b) breadth	94 ft
	(c) depth	54 ft 6 in.
	(d) draught	29 ft 6 in.
	(e) displacement	31,530 ton
	(f) gross tonnage	38,650 ton
	(g) number of propellers	two
	(h) speed	20·5 kn
	(i) speed of the propellers	131 rpm
5	Propulsion plant:	
	(a) double reduction single helical geared turbines	
	(b) number of sets	two
	(c) total shaft horse power	35,000 shp
6	Number of oil fired boilers	four
7	Steam conditions:	
	(a) pressure	640 psig
	(b) temperature	860 °F
8	Electric power for the auxiliaries and ship services:	
	(a) number of turbogenerators	four
	(b) total power	5400 kW
	(c) voltage	440 volt
9	Emergency power:	
	(a) gas turbine driven turboalternator	
	(b) number of sets	one
	(c) rating	350 kW
10	Total number of passengers (two classes)	1,456
11	Total number of officers and crew	776
12	The ship is completely air conditioned and has Denny-Brown stabilizers	

(7) The S.S. *Normandie* and the S.S. *Queen Mary* have three and the S.S. *Queen Elizabeth* and the S.S. *United States* two funnels

(7) Except for the S.S. *Normandie*, which is turbo-electric, geared turbines transmit the power to the four propellers

(8) The total passengers carried varies from 1,962 for the S.S. *United States* to 2,283 for the S.S. *Queen Elizabeth*.

(f) *Plans for new Atlantic liners.*—A recent announcement by a number of countries in Europe and by America of their impressive plans for the construction of new Atlantic passenger liners is of major interest not only to shipping companies, but particularly at the present moment, to shipbuilders. Their primary object is either to replace the existing vessels on the Atlantic route within the next five years or to introduce new ones. This revival in shipbuilding is of paramount importance to marine engineering and naval architecture. Regarding these ambitious projects, the only available information is contained in Table III.

In addition the following facts are of special interest:

(a) The two British liners are for the Cunard White Star Line and they will ultimately replace the S.S. *Queen Mary* and the S.S. *Queen Elizabeth*.

(b) The S.S. *France* of the Compagnie Generale Transatlantique is to replace the S.S. *Liberté*, the ex-*Europa*, which made her maiden voyage under the German flag on March 20, 1930, and gained the Blue Riband at an average speed of 27·91 knots. The S.S. *Europa* had a tonnage of 49,750, a length of 890 ft, a breadth of 100 ft, a design speed of 27·5 knots and carried 2,000 passengers. After the defeat of Germany the Americans took her over as a transport, but only two voyages were made under her flag. Then in May, 1946, she was awarded to France, transferred to Havre and renamed the S.S. *Liberté*. Unfortunately she broke loose in a gale on December 9, 1946, had to be scuttled and was later salvaged. In November, 1947, she was taken to St. Nazaire for reconstruction. Her first trans-atlantic voyage under the French flag was made on August 17, 1950. The revised particulars are indicated in Table IV, which gives also similar information on two other Atlantic liners that are to be replaced in the near future by the S.S. *Rotterdam*, having a tonnage of 38,650, and by a sister ship of the S.S. *United States*, with 53,000 tons (see table III, items 3 and 6).

(c) The new luxury liner, the S.S. *Bremen* (32,000 tons) is the largest to be commissioned in Germany since the war. She is the fifth vessel to have that name. It is interesting to recall that fourth *Bremen*, which was a sister ship to the S.S. *Europa*, made her maiden voyage in 1929 and gained the Blue Riband in both directions without difficulty. She had a tonnage of 51,650, a length of 899 ft, a beam of 102 ft, a speed of 27·5 knots, four propellers and carried 2,000 passengers. Up to the maiden voyage of the S.S. *Normandie* in 1935, she was the largest liner in the world. Three days before World War II she left New York and made for the Russian port Murmansk, arriving on September 6, 1939, and reaching Germany, her home port Bremen, three months later. This world-famous liner burnt out during the Bremerhaven air raid on March 18, 1941, and was broken up very soon afterwards.

The new S.S. *Bremen* was formerly the French troop transport *Louis Pasteur*, sold to a West German Shipping Company after the war and rebuilt in 15 months at Bremerhaven.

Spraying Vitreous Enamel

Special nozzles for their sprayguns have been developed by Alfred Bullows & Sons Limited, Long Street, Walsall, Staffordshire, for spraying vitreous enamel at a low air pressure. The new technique gives a fine coat, an absence of "bounce", and greatly increases the speed of mottling.

Mould Driers

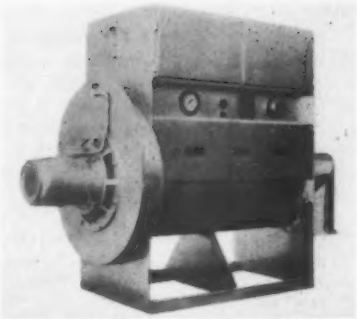
Foundries on the Continent make wide use of a portable Brown Boveri electrical equipment for drying floor moulds and large box moulds. In future they will be available in Britain, made by the Electric Resistance Furnace Company Limited whose principals, Efco Limited, have reached a manufacturing agreement with the Swiss company.

These driers operate by forcing hot air through the sand itself, and have reduced drying times by a half and in some cases by two thirds. The heating is uniform throughout the mould and despite the rapid drying, mould surfaces remain free from cracks and cleaner castings are produced. The driers need no attention during operation, the power input being regulated automatically to maintain the desired air temperature. Working conditions are improved by the elimination of smoke and burning gases.

The equipment consists of an electric air heater, a fan and driving motor, and control gear, all of which is assembled into a single compact unit. The air is heated by being passed at great speed through ceramic tubes containing helically wound heating elements. The fan is fitted with a radially bladed impeller and a diffuser, the impeller being mounted on a strengthened motor shaft. The motor is completely enclosed to protect it from dust and moisture. A single switch is used to bring the drier into operation and to adjust the power input. The air temperature is controlled by a pointer-type mercury thermometer, with minimum and maximum contacts, which switches elements on and off as necessary. A manometer measures the static pressure in the mould and indicates the density of the mould and the porosity of the sand.

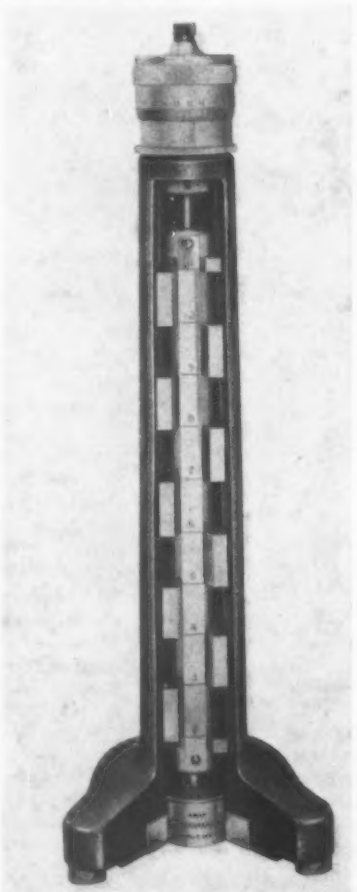
A mould to be dried is covered as for casting and the drier is placed in position over the casting gate. All openings with the exception of the core and coke bed ventilation channels are closed. With the drier in operation, hot air is forced through the mould sand where it gives up its heat and passes out through the ventilation channels saturated with steam. The absence of steam indicates that drying has been completed.

The Electric Resistance Furnace Company Limited will be manufacturing the driers in three ratings

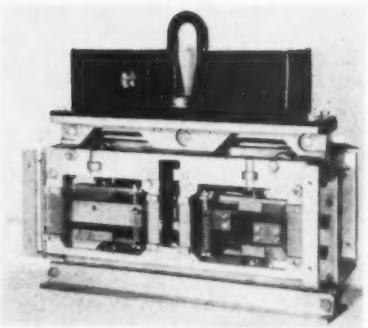


A 70 kW portable electric mould drier of the Brown Boveri type to be manufactured in Britain by the Electric Resistance Furnace Company Limited

of 25 kW, 70 kW and 140 kW, and in two temperature ranges, one for use in grey-iron and other metal foundries where temperatures up to 350° are sufficient, the other providing temperatures up to 650°C. for use in steel foundries.



MICROMETER HEIGHT GAUGE.—A new micrometer height gauge for the tool room and inspection department has been developed by the Amar Tool and Gauge Company Limited of Chadwell Heath. Named the "Accuread", it has a range of from 2 in. to 12 in. and it is accurate to within 0·0002 in; a large drum micrometer permits precise and rapid reading. The measuring faces seen in the illustration enable top or bottom readings to be made directly without any need for calculation or attachments.



ELECTRIC POWER TRACK TROLLEY.—This collecting trolley has a capacity of 200 amp per collector on each of its four bus-bars. Twin terminal boxes enable capacity to be increased to 400 amp per line for d.c. or single phase two wire supplies. The trolley is for use with the electric power track made by Fuller Electric Limited, Fulbourne Road, London E17

Welding Thin Materials

The new "Sigmette" equipment, introduced by Quasi-Arc Limited, of Bilston, Staffordshire, is designed for the rapid semi-automatic welding of ferrous and non-ferrous materials in gauge thicknesses. The equipment is based on the established Sigma process, using a continuous coil of bare wire electrode and shielding by argon gas or by carbon dioxide. Welding is carried out by what is known as the "short-arc" technique, whereby the metal transfer is in globular form, as distinct from the "spray" type of transfer normally associated with Sigma welding.

Welding of all materials can be carried out in every position, including vertically and only the gun needs to be carried to the work.

It weighs only 3 lb 1 oz. and a spool carrying either 1 lb of aluminium wire or 2½ lb of ferrous wire is carried within the gun itself. Welding can be carried out for periods of up to three-quarters of an hour on one spool of wire.

The wire is positioned initially by means of an inching button in the base of the handle. Pulling the trigger starts the gas flow and initiates a slow wire feed. As soon as the arc strikes the full wire speed comes into operation, and is adjustable by a single knob on the voltage control unit.

The gun handles three sizes of wire, being continuously rated at 125 amp for 0·030 in. wire and at 200 amp for $\frac{5}{64}$ in. and $\frac{1}{16}$ in. wires. The standard medium speed wire feed motor fitted gives a wide range of applications with all wire sizes and, in addition, high speed or low speed motors can be supplied for specialized

work using 0·030 in. or $\frac{1}{16}$ in. wires.

The voltage control unit, weighing 19 lb 2 oz, controls all welding variables including wire feed speed and gas flow, and once these are set they are automatically operated by the trigger control on the welding gun. Standard 30 ft leads between the control and the gun allow a wide radius of operation without having to move the equipment.

Two Large Broaching Machines

A turret type vertical broaching machine with two new and exclusive features has been developed by the Lapointe Machine Tool Company of Hudson, Mass., U.S.A. The machine has a 60-ton pull and 78 in. stroke, with a 21-station turret and gives a dead centre pull on the broach. Its overall height is 36 ft, a considerable portion being below floor level, and the machine is fitted with a chip conveyor system. It is used in the manufacture of gate valves.

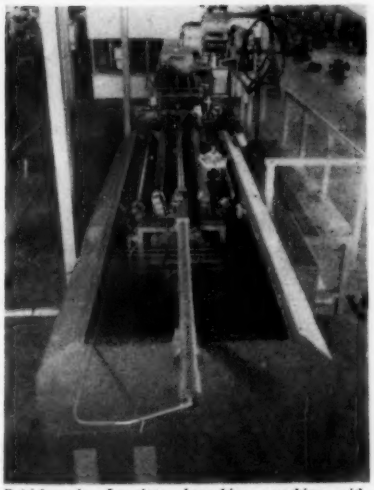
The associate British company, who have their factory at Watford, recently installed a horizontal machine for the Cameron Iron Works in this country for carrying out the identical operation. This machine has a 60-ton pull and 100 in. stroke, with a 19-station turret, and also gives the conventional dead centre pull of horizontal machines.

The American-built vertical machine is completely automatic in operation, and any one of a given number of finished hole sizes can be predetermined by setting the control panel. Each broach in the series will be automatically selected to complete the desired hole size.

The vertical turret is 6 ft dia and holds 20 broaches 80 in. long. An extra open station exists which holds any type of broach, enabling the machine to be used for conventional pull-down broaching.

The broaches are held firmly at both ends during the entire working stroke and are guided for the full length of the cut on hardened and ground slide ways. Finishes as fine as 20 to 25 micro-inches are claimed to be possible when using 20 fpm roughing, and 6 fpm finishing speeds, while the maximum obtainable speeds are 25 fpm cutting, and 50 fpm return of broach. Slow cutting speed is automatically selected by any one of the finishing broaches.

Valve forgings with hole sizes varying from $2\frac{3}{8}$ in. × $2\frac{3}{4}$ in. × 7 in. long up to 3 in. × $7\frac{3}{4}$ in. × $12\frac{1}{4}$ in. long starting from $2\frac{5}{16}$ in. and $2\frac{15}{16}$ in. drilled holes are obtainable. Valve body material used is No. 410 stainless steel in the medium size valves, and S.A.E. 4132 alloy steel in the small and large size valves. Some 36 lb of material are removed to complete the largest hole applicable to the medium range. The 6-way gate valve produced by the American machine has six holes measuring $2\frac{3}{8}$ in. × $4\frac{1}{4}$ in. × 10 in. long, and these are broached at the rate of one complete hole every 15 min. Allowing half an hour for handling, the total floor-to-floor production time is two hours as compared with 78 hr by the previous slotting method.



British-made Lapointe broaching machine with 19-station turret. The broaches are selected by push button control

The British-made horizontal machine is of the conventional type and measures approximately $22\frac{1}{2}$ ft long. Attached to the machine is a 19-station turret horizontally disposed in front of the face-plate and giving the model a total overall length of $37\frac{1}{2}$ ft. The turret is $4\frac{1}{2}$ ft dia and 21 in. below floor level to bring the broaches into line with the machine pull-head. While 18 broaches, measuring 80 in. long are normally used to produce holes up to $2\frac{3}{8}$ in. × $5\frac{1}{2}$ in. × $12\frac{1}{4}$ in. long, an open station is incorporated for larger holes or conventional hole broaching. Each individual broach is selected by the operator, and each movement of the turret and pull-head is controlled through a push-button control panel. However, electrical interlocks are placed at key points throughout the circuitory to guarantee that the ten movements in the cycle occur in their correct sequence.

Cutting speeds are infinitely variable up to a maximum of 12 fpm, with broach return speeds of 80 fpm maximum.

Both the British and American turrets are designed for ease of access to the broaches; any one broach can be removed and replaced in approximately 5 min, and any one station may be used for continuous operation with one broach. Neither machine has been designed for a special application, and may be readily adapted to any single or multiple internal broaching operation.

Aluminium Foil Welding Transformer

The "Balarc 175" is the first welding transformer wound in aluminium foil. Electrolytic treatment of the foil allows temperature rises in the region of 500°C (932°F) and new designs of formers and insulation have made it a robust and durable air-cooled welding unit weighing only 67 lb for easy transportation by means of a handle and comprising high quality components from two-pole switches to duralumin clamps. It is rated for 175 amp continuous operation.

A two-pole, six-way roller switch controls amperage at both 80 and 50 volts O/C at 23 volts welding, running from 190 to 250 volts a.c. single-phase 50 cycles, and draws a maximum of 40 amp from the mains. It retails at £64 10s. 0d. complete with all accessories and is made by the Ashton-Young Engineering Development Company Limited, 76 Cambridge Road, Kingston-on-Thames, Surrey.

Perforated Steel Strip

A modified form of "Addyco" steel strip has been introduced by Addy Products (Sales) Limited, Millbrook Trading Estate, Southampton, to cater for a wider market and more general application than the company's industrial strip. The strip is made from 16 gauge mild steel, rust proofed and painted, and notched and perforated at 1 in. intervals so that it can be bent by hand to any shape and readily assembled or fixed by bolts or screws. It will be useful material to have on hand whenever temporary mountings have to be rigged up quickly or where brackets, connections or the like have to be quickly improvised.

DOWNWARDS PRESSURE

SIDEWAYS PRESSURE

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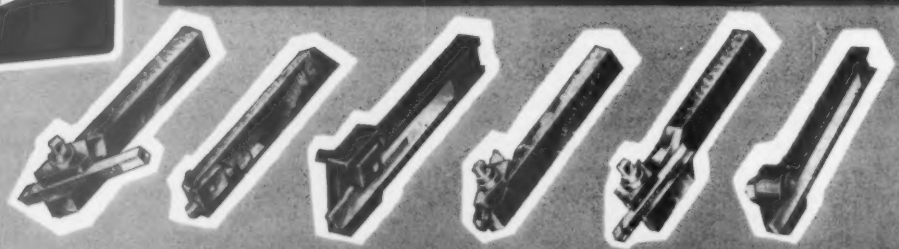
Eclipse



'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

U.T.H.3.

Angus Gear Book. Newcastle upon Tyne, 1959; George Angus & Co. Limited (P.O. Box 139). 15/- net (by post 15/11). Special price to students, 7/6. 175 pp. 6 × 9 in.

The majority of engineering firms who embody gearing in their designs do not themselves make gears but buy them to their requirements from specialist manufacturers. This is not to say that they are not interested in gear design; in most cases they are very much concerned with it. Among books on gearing this new volume from Messrs. George Angus & Co. Limited, who are well known as manufacturers of gearing of all descriptions, is certain to have wide appeal since it presents much useful information concisely and in systematic form. It is fully illustrated and gives all the relevant formulae both in the text and in summaries which will be particularly handy for reference. The types dealt with are spur gears, single and double helical gears, bevel gears, internal gears, spiral gears, and worm gears. There are also chapters on gear materials, gear tooth loading and carrying capacity, and gear failure.

Analytical Elements of Mechanics, Vol. I. By Thomas R. Kane. New York, 1959. London; Academic Press Inc. (London) Limited. $4.75 net. 250 pp. 5¼ × 8¼ in.

The treatment of classical mechanics in this first of two volumes is on a sufficiently general level to encompass the full range of phenomena which has to be considered when applying principles to the solution of problems arising from various fields. The author uses vector analysis as the main medium of symbolic language and with it does much to simplify both the presentation of theory and the solution of problems. Proofs and derivations he gives in considerable detail, but he has evidently refrained from discursive treatment for attention is everywhere to concise definitions, problems and solutions, all systematically arranged and classified. One certainly wastes no time in reading. On any topic one is into the heart of the matter right away and in no time delving into problems and solutions. It is a good book for serious study and should be very useful for reference.

Design of Welded Pipe Fittings.—British Welding Research Association has published a new handbook, The Design of Welded Pipe Fittings under the authorship of P. H. R. Lane, B.Sc.(Eng.), A.I.M. and R. T. Rose, B.Sc., Ph.D. The booklet gives details of extensive stress measurements on pipe bends, or welding elbows. Von Karman's classical method of calculating the stresses has been extended to be applicable to short-radius and thin-walled bends which have been increasingly used in recent years. The experiments have confirmed the validity of the proposed calculation.

Stress measurements on fabricated branch connexions are also described. These give a rational basis for a comparison between the effectiveness of various forms of reinforcement currently in use, or which have been proposed for use. A further section deals with fatigue strength of pipe butt joints, and of various designs of end closures for model headers. From this work important conclusions have been drawn concerning detail design of welds to attain maximum efficiency, and the importance of various classes of defect. A final section gives guidance on the application in practical design work of the research data reported.

books

Guide to Makers of Cutting Tools.—The National Federation of Engineers' Tool Manufacturers has published its first "Guide for Buyers" which gives details of the suppliers of British made engineers' cutting tools. A feature of the publication is the alphabetical list of tools in four languages—English, French, German and Spanish. Overseas buyers will have no difficulty in finding in the guide the names and addresses of British suppliers of all types of engineers' cutting tools. Part 4 of the guide contains an alphabetical list of trade marks, trade names and brand names. Copies may be obtained from the N.F.E.T.M., Light Trades House, Melbourne Avenue, Sheffield, 10, price 5/- each (including postage).

New Export Service Bulletin.—On January 1, publication of the (Board of Trade's) Special Register Information Service in its present form was discontinued and in its place a new printed Export Service Bulletin is being issued three times weekly on Mondays, Wednesdays and Fridays. It contains all the urgent information about overseas calls for tender and export opportunities formerly published as individual circulars in the Special Register Information Service. In addition, on every Monday, a weekly supplement is published which contains the latest economic reports and market commodity reports received from the United Kingdom Commercial Diplomatic and Trade Commissioner Services overseas. Annual subscription is £10 10s. 0d. post paid (additional subscriptions £5 5s. 0d. per copy).

Improved Material Utilization.—A new report of this title contains over 80 proved case studies, fully illustrated, and covering the fields of finishes and finishing materials, packaging and shipping materials, ceramics, metal powders and plastics, and ancillary processing materials. Copies may be obtained from the Publications Department, The Institution of Production Engineers, 10 Chesterfield Street, Mayfair, London, W1, price 12/6 (by post 13/6).

New Standards

Ropes and Fittings (B.S. Handbook No. 4: Lifting tackle. Part1 : 1959). Price 30/- net.

This revised edition of B.S.I's popular Handbook No. 4 (Part 1), by Mr. L. Linder, M.I.Mech.E., is the first of two parts: Part 2, "Chains and Fittings", is expected to be published shortly.

Part 1 deals with the material contained in Sections 1, 2, 3 and 7 of the first edition. Each of the standards it contains has been reproduced in full, and (except for that on capping metal) revised. The two basic standards are those for natural fibre ropes (B.S. 2052) and for engineering wire ropes (B.S.'s 302 and 621, combined). Complementary to these are standards for steel wire for ropes (B.S. 2763) and for testing the coating of galvanized wires (B.S. 443). The standards for terminal attachments are B.S. 461–464 (Bordeaux connexions, bulldog grips, sockets and thimbles respectively) and B.S. 716 (rigging and stretching screws). Other standards deal with galvanizing tests (B.S. 729), capping metal (B.S. 643) and wire rope slings (B.S. 1290). The new publication contains nearly 100 pp. of revised and extended editorial notes. Among the subjects dealt with are factors of safety, types and

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constructions of wire ropes, the use and examination of rope, terminal splicing and co-efficients for estimating rope tensions in pulley systems. The historial aspect has also been briefly indicated. Nearly 50 pp. are devoted to statutory requirements.

Twist drills (B.S. 328. Part 1:1959). Price 15/- net.

Revised to incorporate work done in recent years on the international standardization of twist drills, this new edition of B.S. 328 contains dimensional tables for jobber, stub and long series twist drills and for Morse taper shank drills and core drills. All the tables are fully in accordance with (draft) ISO Recommendations for these types of tools. Common flute and overall lengths ensure that drills in any one size range have the same general dimensions whether made in the inch or metric system of measurement. The lengths are in a logical series of increments and are designed to be efficient and economical in use.

A comprehensive table gives the flute and overall lengths of all standard sizes of different types of drills.

Screw threads of Unified form for spectacle frames including screwing taps and screw gauges (B.S. 3172: 1959). Price 4/6.

One of a series being prepared on ophthalmic subjects, this new standard specifies, for spectacle frames, Unified form of screw threads (B.S. 1580) in the following nominal sizes:

Nominal size (Maximum major diameter) in.	*Pitch* tpi
0·0558	64
0·0583 (repair size)	64
0·0463	90
0·0558 (repair size)	90

The related taps and gauges are specified and recommendations for gauging practice are given in the Appendix. It is intended that the forthcoming standard for spectacle frames will include further details relating to screws, since this British Standard specifies only the screw threads and their related taps and gauges.

Translations of German Industrial Standards

The German Standards Committee (Deutscher Normenausschuss), Berlin W 15, has established a special department to prepare translations of German industrial standards in English. So far, 500 English translations have been made. New lists of the translations available may be obtained free of charge from the Beuth-Vertrieb GmbH, Berlin W 15, Uhlandstr. 175.

Paper-covered copper conductors (B.S. 2776: Part 1: 1959. Round wire). Price 6/-.

With the publication of this new part, B.S. 2776 has been extended to cover round wire as well as rectangular conductors. Part 1 deals, however, only with double-paper-covered wire, whereas requirements for both double and multiple paper coverings on rectangular conductors are given in the original standard which now becomes B.S. 2776: Part 2. The requirements and the tests are generally similar to those specified in B.S. 2776: 1956. They cover both the quality of the paper and the properties of the finished conductor.

British Standards Institution, 2 Park Street, London, W1.

Refuelling Hose

Four types of refuelling hose, specially developed by Goodyear, are now in use by the Admiralty for refuelling ships of the Royal Navy at sea. Hoses of rayon construction are used for fuelling abeam and hoses of Terylene construction for fuelling astern. Both constructions are made with alternative compounding—one for handling furnace oil and the other for high-octane fuels for carrier-borne aircraft.

The original war-time design was a hose of 5-in. bore with square woven cotton reinforcement, made up in 60-ft lengths and supported by a jackstay slung between the supply vessel and the ship. The design incorporated special externally wire-armoured end connexions 15-ft long. A new design in 30-ft lengths was introduced in 1948, and by 1950 a hose with rayon reinforcement had been standardized. A rayon hose could withstand the additional stresses of the new method of astern fuelling (without jackstays) and would also float when filled with furnace oil, but had a considerably reduced capacity when used for the astern method owing to severe load which caused elongation and reduction in bore.

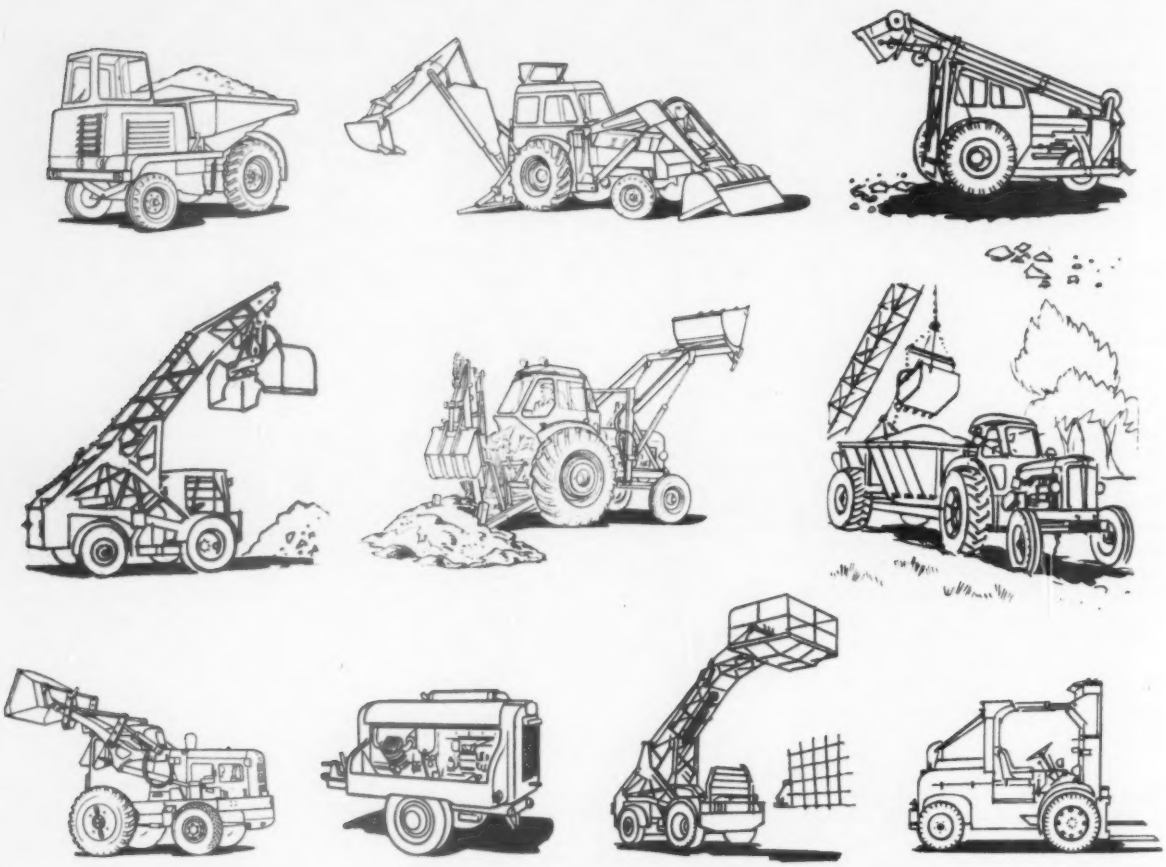
Further investigation, initiated towards the end of 1953, eventually led to the thorough testing of two new designs—both 6-in. bore hoses with Terylene reinforcement. Sea trials and operational experience resulted in a decision favouring the lighter construction of the two, a hose giving a high rate of flow for astern fuelling coupled with easy handling, buoyancy when filled with air or fuel, and strength to withstand the severity of an exacting duty.

Safety Information

This year the Industrial Safety Division of the Royal Society for the Prevention of Accidents will begin its part in an international scheme intended to promote wider understanding of industrial safety and allied subjects among safety officers, works managers, industrial physicians, trade unionists and research workers. The essential aim of this scheme is to make information available, rapidly and systematically, on literature and legislation dealing with all aspects of occupational safety and health. Every type of industrial activity will be covered, including engineering, mining and quarrying, agriculture, transport, dock work, public services and civil engineering.

Distribution of the information will be made through the International Labour Office by means of index cards. Literature to be dealt with will include reports and specialized publications of all descriptions, and books and periodicals from countries throughout the world. Laws and regulations, codes, standards, specifications, instructions and other texts of a legislative nature will also be given systematic coverage. The cards, each with a classification code number, will consist of a complete index of subjects and cross references, and each item of information will appear on only one card. Cards will be obtainable, in complete sets only, from the national organizing centre which, in Great Britain, will be the Royal Society for the Prevention of Accidents.

The cost to British subscribers will be £14 5s. 0d. a year. Enquiries should be addressed to the Royal Society for the Prevention of Accidents, Terminal House, 52 Grosvenor Gardens, London, SW1.



TOP DESIGNERS *INSIST* ON

FORDSON POWER

Britain's top designers of industrial machinery choose more Fordson power units than any other. For very good reasons too . . . proved reliability, high output at low cost in the toughest conditions, almost unlimited choice of build-ups in the 30-40 b.h.p. and 40-50 b.h.p. classes, and the backing of the Fordson world-wide service and spares organisation. And all with the low costs that come from quality volume production in the great Dagenham plant. Write for detailed specifications.

WISE BUYERS INSIST ON FORDSON POWER

INDUSTRIAL SALES DEPARTMENT TRACTOR DIVISION FORD MOTOR COMPANY LIMITED DAGENHAM ESSEX

BUSINESS & PROFESSIONAL

Personal

KERRY'S (GREAT BRITAIN) LIMITED, announce that **Mr. V. J. Geary** previously employed at their Brighton depot, has been appointed depot manager at Luton depot.

Mr. F. P. Laurens, O.B.E., M.I.Mech.E., M.I.Prod.E., assistant managing director, Production, of International Computers and Tabulators Limited, resigned from the board of directors of Vickers-Armstrongs Limited on December 31, 1959.

Mr. H. M. Medhurst, who has been in the electrical industry for 50 years, has just retired. For the last 23 years he was sales engineer at the London office of Laurence, Scott & Electromotors Limited.

ELCONTROL LIMITED announce that **Mr. B. A. Worswick B.Sc.(Hons)., A.Inst.P.,** until recently chief engineer of Fischer & Porter Limited has been appointed to the post of technical director with a seat on the board.

Mr. G. F. Paveling, shop superintendent of the Uppark Drive factory of The Plessey Company Limited, at Ilford, has now retired. He had been with the company for over 35 years; only four other members of the company—including the chairman, Mr. A. G. Clark—have longer service.

WAKEFIELD-DICK INDUSTRIAL OILS LIMITED have appointed **Mr. J. W. Davies** as their representative for the Sheffield area, in succession to **Mr. A. S. Watson** who retires after 35 years in a similar capacity.

THE COVENTRY VICTOR MOTOR COMPANY Limited, of Coventry and London, announce the appointment as engineering consultant of **Mr. E. Chatterton, B.Sc.(Eng.), M.I.Mech.E., F.R.Ae.S.,** who, in collaboration with the chairman, Mr. W. A. Weaver, will assume full responsibility for all engineering aspects of their business.

IN H.M. the Queen's New Year Honours **Mr. L. J. Davies, M.A., B.Sc.(Oxon.), M.I.E.E., F.I.E.S.,** director of research and education, A.E.I. (Rugby) Limited, (formerly BTH) was awarded the C.B.E., and **Mr. A. G. W. Cannon,** manufacturing manager of A.E.I. motor and control gear division, the M.B.E.

Mr. E. S. Little, Comp.I.E.E., F.I.A.C., director of British Thomson-Houston, retired on December 31 after 48 years with the company.

A.E.I. (Rugby) Limited announce the appointment of **Mr. L. C. J. Carvill, M.P.O.A.,** as supervisor of purchases, to succeed **Mr. O. A. Pallett** who continues with the company in a consultative capacity.

Mr. J. E. A. Heale, formerly works manager of the Motherwell works of Metropolitan-Vickers (now A.E.I. (Manchester) Limited), has joined Associated Electrical Industries (Woolwich) Limited, as general manager of works.

Mr. C. T. M. Bagnall, who has been publicity manager with The English Electric Company since 1952, is appointed to a new post of manager, Publicity and Information Services. This new title carries responsibility for both the company's public relations and publicity departments. **Mr. A. E. Bates, M.I.E.E.,** has taken up a new appointment as manager of The English Electric Company's office in Edinburgh. Mr. Bates succeeds **Mr. W. M. Todd** who was recently transferred from Edinburgh to manage the company's Bristol office.

BRITISH RAILWAYS (SCOTTISH REGION) announce the appointment of **Mr. J. J. Finlayson** as chief mechanical and electrical engineer, Scottish Region.

Mr. B. Rosen has been appointed managing director of Sandvik Swedish Steels Limited, Halesowen, Birmingham, as from February 1, 1960. He succeeds **Mr. Olof Grundberg,** managing director of the company since 1947.

VICKERS-ARMSTRONGS LIMITED announce the following appointments: Vickers-Armstrongs (Engineers) Limited: **Mr. A. E. Reddell, O.B.E., M.I.Prod.E.,** is appointed a director and to the office of director-in-charge, Weymouth Works. **Mr. F. A. E. Pritchard, M.I.Prod.E.,** is appointed a special director and to the office of general manager, Weymouth Works. Vickers-Armstrongs (Aircraft) Limited: **Mr. J. Ferguson Smith, A.C.A.,** is appointed a special director.

THE First Lord of the Admiralty has approved the appointment of **Mr. P. T. Williams** to be director of Navy contracts in succession to **Mr. B. Pool, C.B., C.B.E.**

CHANGES in the boards of two of the electrical subsidiaries of the Metal Industries Group are announced. **Mr. J. H. Rawlings** has relinquished the position of managing director of Avo Limited but is remaining on the board of the company as deputy chairman, and also on the board of Brookhirst Igranic Limited. Succeeding him as managing director of Avo is **Mr. S. R. Wilkins. Mr. E. Strauss** has been appointed director and general manager of Taylor Electrical Instruments Limited.

Mr. John L. Lutyens, M.A., A.M.I.Mech.E., has been appointed group director of research by the Pressed Steel Company Limited, Cowley.

Mr. G. L. Knight has been appointed assistant to captain R. A. Villiers, director of SIMA.

Mr. Hartford M. King, O.B.E., sales director of Geo. W. King Limited, Stevenage, Herts, has been appointed assistant managing director.

Dr. H. H. Burton, C.B.E., has retired from the board of directors of English Steel Corporation Limited. He will continue as research consultant to the group until December 31, 1960. **Mr. T. R. Middleton, B.Sc.,** has been appointed a director of English Steel Corporation Limited, and director of research with effect from February 1, 1960.

Mr. A. E. Osborne, London office manager for McCall & Co. (Sheffield) Limited, has recently been appointed a director of the subsidiary company McCalls Macalloy Limited.

SOUTHERN AREAS ELECTRIC CORPORATION Limited announces the following appointments in two of their subsidiary companies: **Mr. S. H. Tombs,** general manager of Globelite Industries Limited, of Marsh Green Road, Exeter, coil and armature winders and repairers of electrical equipment, has been elected to the board of that company. **Mr. John Airlie,** general manager of Carrick Engineering (Stewarton) Limited of Stewarton, Ayrshire, manufacturers of press tools, jigs and fixtures, has been elected to the board of that company.

CONSEQUENT upon his appointment to the executive board of The Incandescent Heat Company Limited, **Mr. P. M. Williams** has relinquished his post as manager of the Foundry Plant Division of the company. His place is now taken by **Mr. J. S. Perks,** previously assistant manager who will be assisted by **Mr. M. Jurkowski.**

Mr. G. C. Derbyshire, A.M.I.Mech.E., A.M.I.Prod.E., A.M.I.W.M., has been appointed works and technical director of Jacobs Manufacturing Company Limited, and Frank Guylee and Son Limited, of Sheffield, and **Mr. J. C. Greig** has been appointed sales director.

THE appointment of Mr. Edwin E. Hewett as sales engineer is announced by Nash & Thompson Limited, of Hook Rise, Tolworth, Surbiton, Surrey.

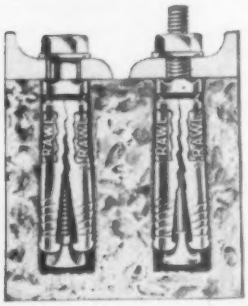
THE METALLURGICAL EQUIPMENT EXPORT Company Limited announce that **Mr. D. F.**

A RAWLPLUG HEAVY DUTY FIXING DEVICE

RAWLBOLTS

There is no waiting for cement to harden when you use Rawlbolts. The holes are drilled with a Rawltool to the exact size, the Rawlbolts dropped in and after the machine has been positioned the bolts are tightened. The expansion of the members locks the bolts in the holes. They cannot work loose through vibration or shock. The machine can be put into operation immediately.

Rawlbolts have earned a sterling reputation for strength and reliability throughout the world—they are used by the million every month. Rawlbolts grip by *expansion*—their strength as a fixing is based on the enormous compressive strength of concrete itself.



RAWLBOLTS ARE MADE IN TWO TYPES

For fixing heavy machinery to floors there is the Loose Bolt type of Rawlbolt which enables the machine to be slid into position after the Rawlbolt has been inserted. For wall fixings use the Bolt Projecting type which will position the fixing before tightening up.

Please write for Chart and descriptive literature.

Tools that save time For hole boring there is a big range of high efficiency Rawlplug tools for use by hand, electric and air power.

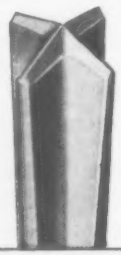
RAWLDRILLS

For hand boring for Rawlbolt sizes A to G.

B545A

STARDRILLS

For hand boring for all Rawlbolt sizes.



DURIUM MASONRY DRILLS

For use in hand and electric drills for Rawlbolt sizes C to G.

TRIFORM DRILLS

For use in electric hammers for Rawlbolts sizes C to K.

DURIUM HAMMER DRILLS

For use in electric hammers for Rawlbolt sizes C to J.

P. H. BITS

For use in pneumatic hammers for Rawlbolt sizes E to K.

RAWLPLUG CO. LTD., CROMWELL ROAD, LONDON, S.W.7. | *THE WORLD'S LARGEST MANUFACTURERS OF FIXING DEVICES.*

Campbell, formerly chairman, has been appointed president, and the chairmanship will be held in rotation by the managing directors of the companies constituting the consortium. **Mr. R. B. Potter** has been appointed chairman for the next two years, with **Mr. P. Wrightson, O.B.E.,** as deputy chairman for the same period.

Mr. A. E. Gregg, Assoc.M.C.T., Assoc.I.E.E. has been appointed a director and general manager of Crompton Parkinson (Chelmsford) Limited.

Mr. T. H. Clarke, formerly sales manager of Patterson Lamps (1953) Limited, of Gateshead-on-Tyne, has been appointed general manager as from January 1, 1960.

CABLE & WIRELESS LIMITED announce the appointment of **Mr. G. W. T. King,** formerly assistant contracts manager, as contracts manager in succession to **Mr. R. C. F. Saxby,** who has retired. **Mr. S. W. Austin** of the contracts department succeeds Mr. King as assistant contracts manager.

THE HADFIELDS GROUP OF COMPANIES announce that **Mr. T. H. Arnold, M.B.E., F.I.M.,** has relinquished his appointments as local director and controller of the research department and also as a director of the subsidiary companies, Hadfields Steels Limited, and Hadfields Forgings Limited. **Mr. L. G. Finch, B.Met., Ph.D.,** succeeds Mr. Arnold as local director and controller, research department and **Mr. J. A. Grainger, M.Eng.,** has been appointed deputy research controller.

Mr. R. T. W. Anderson, D.F.H., M.I.E.E., has been appointed district manager at the Birmingham Works of British Electrical Repairs Limited, in succession to **Mr. J. Ashmore, M.I.E.E., Assoc.I.Mech.E.,** who is retiring after 26 years as district manager at the B.E.R.L. Birmingham Works.

Mr. Kenneth Baird has been appointed personnel manager of F. Perkins Limited, of Peterborough.

Mr. T. M. Horn has retired from the position of manager of the Leeds branch of Atlas Copco (Great Britain) Limited and is succeeded by **Mr. A. W. Tombleson,** from the firm's Manchester branch. The existing Leeds area has been divided and a new branch office is being established in Newcastle under the managership of **Mr. W. Hossent.**

MASSEY-FERGUSON has announced further senior executive appointments in the newly established United Kingdom Operations. Director planning and procurement, **Mr. I. J. Wallace;** director marketing, **Mr. T. V. Knox;** director personnel and industrial relations, **Mr. A. J. Scamp.** For the time being the appointment of director manufacturing will be filled by **Mr. H. A. Wallace,** vice-president, manufacturing, Massey-Ferguson Limited and that of Comptroller by **Mr. J. G. Staiger,** assistant to the president. The name of Massey-Ferguson (Great Britain) Limited has been changed to Massey-Ferguson (United Kingdom) Limited. This subsidiary company will provide the management functions required for United Kingdom operations.

Mr. A. S. King has retired from his position as executive director of The Vacuum Brake Company Limited after 40 years' service.

Sir Owen Wansbrough-Jones, K.B.E., C.B,. has been appointed a director of The British Oxygen Company Limited.

Mr. Charles William Reester, general manager of Mortimer Engineering Company for many years, has now been appointed to the board of directors of S. Guiterman and Company Limited, proprietors of Mortimer Engineering Company.

Mr. Paul Gotley, A.M.S.E., was recently appointed general manager of Equipment & Services Limited.

Mr. C. R. Woodfield has been appointed general manager of the new Group Works Division formed by The Wakefield Castrol Group, and **Mr. H. G. Priest** manager of the production department, based at Castrol House, London.

Obituary

WE regret to record the death of **Mr. Horace Victor Ellis** in his 63rd year. Mr. Ellis was a director of The City Electrical Company.

WE regret to record the death of **Mr. James Thomson,** late conveyor engineer of Mavor & Coulson Limited.

Addresses

A new North Midlands sales area including Sheffield, Barnsley, Doncaster, Scunthorpe, Derby, Nottingham and Lincoln and the surrounding districts has been set up by Nife Batteries of Redditch. The engineer in charge of this new area is Mr. P. Sandels, formerly of the Manchester area, who will be located at 4 Ordsall Park Road, Retford, Notts. Telephone number Retford 2330.

THE UNITED STEEL COMPANIES LIMITED, Sheffield, public relations department has removed from Westbourne Road to The Mount, Broomhill, Sheffield, 10 (GPO Box 64). Telephone numbers are unchanged.

THE telephone number of Higgs & Hill, Limited, Crown Works, South Lambeth Road, London, SW8, has been changed to RELiance 7688.

AN increase in the number of telephone lines serving the works and offices of Electropol Processing Limited, Trading Estate, Farnham, Surrey, pioneers in the electro-polishing of stainless steel has involved a change in number to Farnham 3355.

BRITISH WELDING RESEARCH ASSOCIATION has changed its London office address to 19 Fitzroy Square, W1. Telephone: EUSton 9595/6. Telegrams: Weldaserch, Wesdo, London.

NEW production and distribution centres in Australia and India are announced for the Freyssinet and P.S.C. prestressing systems. Both factories will be under the personal supervision of Mr. J. V. Turner, chairman and managing director of P.S.C. Equipment Limited of Uxbridge, who was recently appointed President of the new International Co-ordination Committee for Prestressing.

SOUTHERN INDUSTRIAL RUBBER LIMITED, the southern distributors of Goodyear Industrial Rubber Products have opened new premises at 7a, The Green, West Drayton, Middlesex. Telephone number, West Drayton 4343.

RHODEN PARTNERS LIMITED, design and development engineers in mechanical and production engineering, have recently removed from Park Crescent, London, W1., to larger premises at 19 Fitzroy Square, W1. (Telephone: EUSton 9696).

NASH & THOMPSON LIMITED have acquired a second factory at Hook Rise, Tolworth, within 200 yards of their present research and production unit in Oakcroft Road, Chessington, Surrey.

A new service depot for London and the Home Counties has been opened at Ripple Road South, Barking, Essex, by the British Materials Handling Division of The Yale & Towne Manufacturing Company. The telephone number is DOMinion 5945.

HIGH DUTY ALLOYS LIMITED have moved their Glasgow office to De Quincey House, 48 West Regent Street, Glasgow, C2. Telephone: Douglas 1500.

THE TEDDINGTON GROUP OF COMPANIES (Watson, Manasty & Co. Limited, George Dearden Limited, Novelectrix Limited, Educational Models Limited, Opticology Limited) have changed their address from Kingston-on-Thames to Orleans House, Manor Road, Teddington, Middlesex. Telephone TEDdington Lock 3411 (four lines).

Business Developments

Trading agreements

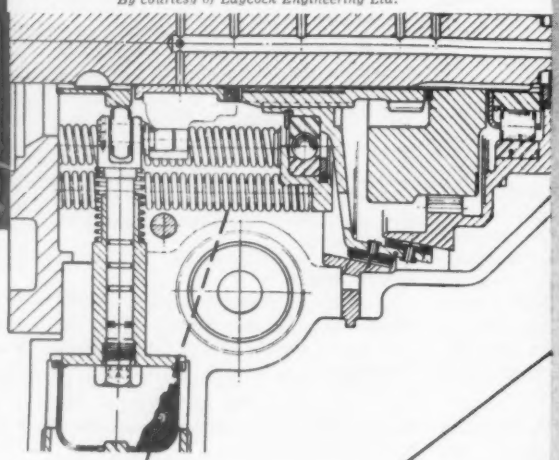
IN agreement with Templet Industries Inc., of Brooklyn, U.S.A., Hordern-Richmond Limited of Gloucester are now responsible for the European license sales of the Templet industrial blanking tool process.

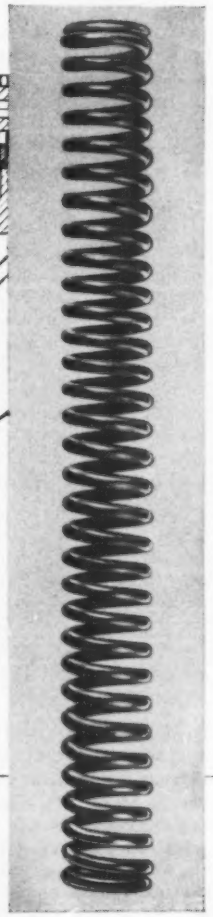
A manufacturing license and selling agreement for Tobenoil Limited's packaging division with the Nelson Parks Corporation of Seattle, U.S.A., for the manufacture of Wrapmaster has been concluded. The agreement covers the U.K., the Commonwealth and Europe and certain other selected countries.

Vital links in controlled movement

A body needs muscles to control movement in very much the same way as a mechanism needs springs. These vital links take the stress and strain of every day rigorous use — nature provides the muscles SALTER provides the springs. Two centuries of experience and development in the manufacture of springs of every type have enabled us to keep ahead of the ever-changing requirements of industry.

By courtesy of Laycock Engineering Ltd.





For springs with the highest reputation and top performance specify SALTER all-action springs.

The applications for SALTER springs are wide and varied — from heavy machinery to finely balanced instruments.

SALTER ESTABLISHED 1760

GEO. SALTER & CO. LTD.
WEST BROMWICH
ENGLAND

AN agreement involving the construction of new and expanded plant for the manufacture of petroleum chemicals in New South Wales has been reached between Shell Chemical (Australia) Pty. Limited and Imperial Chemical Industries of Australia and New Zealand Limited.

PANTAK LIMITED of Vale Road, Windsor, Berks., have concluded an agreement with Usines Balteau of Liége for the marketing in the U.K. of two ranges of lightweight portable industrial X-ray equipment.

THE manufacture and marketing in the U.K. of Surform and Surcut surfacing and cutting tools has now been transferred from Simmonds Aerocessories Limited to Firth Cleveland Tools Limited. Both companies are members of the Firth Cleveland Group.

AGREEMENT has been concluded between Kelvin & Hughes Limited and the Curtiss-Wright Corporation of America for the exclusive right to manufacture and sell the non-destructive testing equipment of the other partner.

STEEL & CO. LIMITED are in agreement with Unit Crane & Shovel Corporation of Milwaukee, U.S.A., whereby Unit will manufacture Coles cranes in Milwaukee and will market these throughout U.S.A., Canada and Mexico under the name Unit-Coles. R. H. Neal & Co. Limited will manufacture Unit cranes, excavators, etc., in Grantham and will market them throughout the Eastern Hemisphere under the name Neal-Unit.

WM. SIMONS & CO. LIMITED and Lobnitz & Company Limited of Renfrew, Scotland, will in future trade together as one company under the name Simons-Lobnitz Limited, operating within the Weir Group of Companies.

WILLIAM BOBY & CO. LIMITED, water treatment engineers of Rickmansworth, Herts, are entering the Australasian market and establishing local manufacture of plant in conjunction with Australian firms.

Agents and distributors

AIR PUMPS LIMITED have announced the appointment of the Building Equipment Division of Scaffolding (Great Britain) Limited of Mitcham, Surrey, as sole selling agents for the entire range of A.P. air compressors in Kent, Surrey and Sussex.

THOMAS MERCER LIMITED, dial and air gauge manufacturers of Eywood Road, St. Albans, have been appointed sole industrial distributors in the U.K. for the honing machines manufactured by the Sunnen Products Company of 7910 Manchester Avenue, St. Louis, 17 Missouri, U.S.A.

PHOTOELECTRONICS (M.O.M.) LIMITED, manufacturers of photocells, photo-transistors and electronic controls have appointed Paton Bros. Engineering Services of 15, St. James's Row, Sheffield, 1, and 30 Northenden Road, Sale, Cheshire, as their representatives for Yorkshire, Lancashire and Cheshire.

STUART DAVIS LIMITED, Coventry, are now sole agents in the United Kingdom for the Johansson (Swedish) range of cylindrical plain and universal grinders.

Company acquisitions

FIRTH CLEVELAND's agreement to acquire a 53·125% interest in the Solartron Electronic Group Limited will provide £900,000 immediately to finance Solartron's next five-year period of development.

THE American tractor firm, J. I. Case Company, has formed a £1m. British subsidiary, registered as J. I. Case Company Limited, with headquarters in London.

Contracts and Work in Progress

HUNT & MITTON LIMITED.—Several orders from agents in the Argentine for high and low pressure valving for steam and feed water for thermal power station; from Francis Shaw & Co. Limited for automatically operated valves for rubber tyre factory in Bulgaria, and from Simon Handling Engineers Limited for stainless steel valves for Ukraine tyre factory. Total value £20,000.

B.I.C.C. LIMITED.—Overhead equipment for electrification of the Polish State Railways. First consignment dispatched last December.

ASSOCIATED ELECTRICAL INDUSTRIES Limited.—*Heavy Plant Division.* Two orders for waterwheel alternators for North of Scotland Hydro-electric Board. Orders worth nearly £700,000 for electrical equipment for Australian rolling mills.

BLAW KNOX CHEMICAL ENGINEERING Company Limited.—Contract for additional polyvinyl acetate emulsion plant to be erected at the National Adhesives Factory at Slough.

WILLIAM BOBY & CO. LIMITED.—Contract valued at £18,500 for extensions to the existing Boby automatic base-exchange water-softening plant for the North Lindsey Water Board's pumping station at Barrow-on-Humber.

ELECTRIC RESISTANCE FURNACE COMPANY Limited.—Order value £33,000 from A. P. Newall & Co. Limited of Glasgow for continuous automatic heat treatment plant. Order value £15,000 covering supply of six Efco-Lindberg furnaces for U.K.A.E.A.

PERKINS ENGINES LIMITED, Peterborough.—Orders for 1,430 Perkins engines totalling about $700,000 from U.S.A.

E. G. IRWIN & PARTNERS LIMITED.—Spanish contract value £100,000 awarded for materials handling plant. Main contractors are Mecanica de la Pena S.A. of Bilbao.

HEENAN & FROUDE LIMITED.—Orders from Machinoimport, Russia and from Poland for Froude hydraulic dynamometers.

BROOKHIRST IGRANIC LIMITED.—Equipment valued at around £75,000 for new plate mill at the Consett Iron Company.

CRANE controls valued at nearly £60,000 for Joseph Adamson & Company of Hyde.

VICKERS LIMITED.—Contract for the supply of two complete beet sugar factories for the U.S.S.R. Value around £8 million and follows the contract already negotiated by Vickers and Bookers for over £500,000 for beet sugar equipment for the Soviet Union.

J. G. STATTER & CO. LIMITED, (Lancashire Dynamo Group).—Further contract from the Government of Kuwait Electricity Department for the supply of HV metalclad switchgear, value about £175,000.

P. G. ENGINEERING LIMITED.—Contract from North Eastern Gas Board for plant to reform natural gas, Whitby Gasworks.

INTERNATIONAL COMPUTERS & TABULATORS Limited.—Orders from three commercial concerns in France for general purpose computer, I.C.T. Type 1202. Orders value £60,000 in each case.

BRITISH RAILWAYS, SCOTTISH REGION.—Contracts placed with R. H. Neal & Co. Limited, London (three mobile cranes); and with Underhill Heating Engineers Limited, Glasgow, for low pressure hot water heating installation.

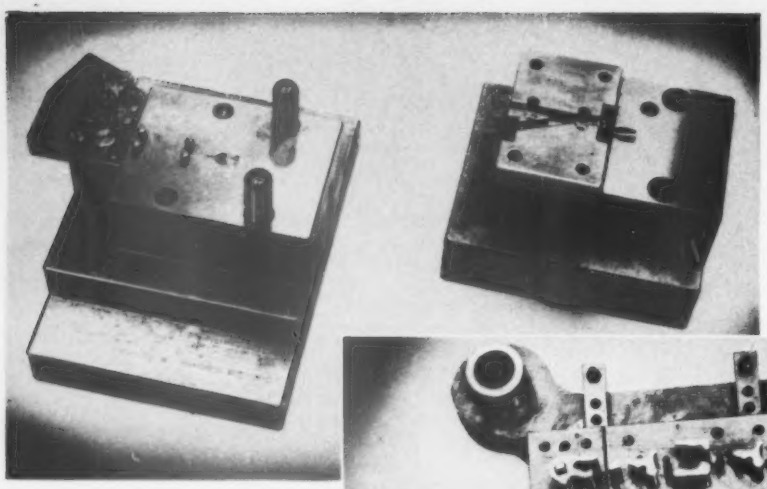
Film News

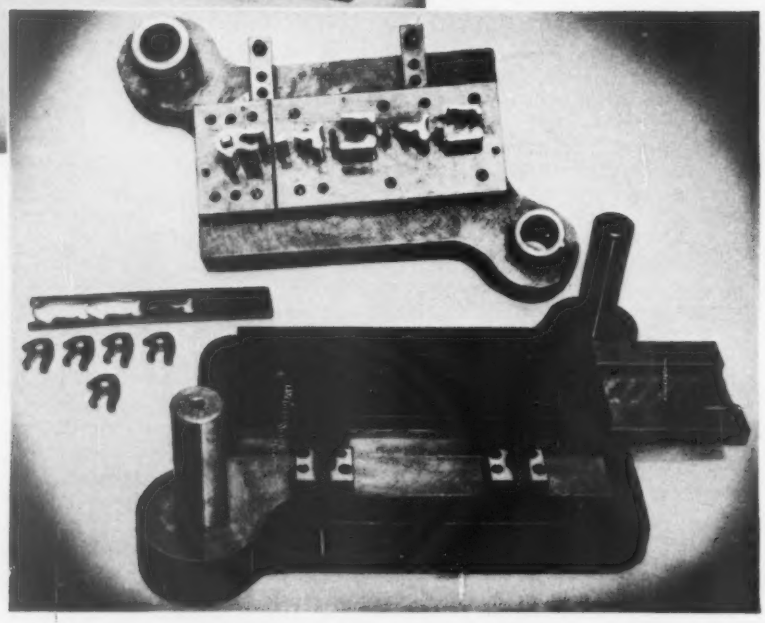
Infra-red Heat in Industry.—Available from the General Electric Company Limited, this 16 mm. colour sound film (for projection at silent speed) explains the nature of infra-red heat and its applications to industrial processes such as plastics, paint stoving and nylon setting. Running time 18 min. Application for free loan should be made to Industrial Heating Department, G.E.C., Magnet House, Kingsway, London, WC2.

Stop it Please.—This is the Brook Film Unit's latest release: it shows the very wide range of control gear made by the company and has several light moments. It is in 16 mm. colour and runs for 13 min. Available on free loan from Brook Motors Limited, Empress Works, Huddersfield.

Research Scholarship

A research scholarship in the use of light alloys in structural engineering is offered every third year by the Institution of Structural Engineers in collaboration with the Aluminium Development Association. The duration of the scholarship is two years and the value £600 per annum. The next award will be made this year to date from October 1st, 1960. Details and application forms are obtainable from the secretary of the Institution of Structural Engineers, 11 upper Belgrave St., London SW1, and should be returned to reach the Secretary by March 31, 1960.





4 times as much with DOUBLE SIX!

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Double Six is like that: just one of the many die steels we produce for applications from blanking and tin-making to mandrels, ring gauges, etc.

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To Edgar Allen & Co. Ltd., Sheffield 9.
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EDGAR ALLEN & CO. LIMITED
IMPERIAL STEEL WORKS · SHEFFIELD 9

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Calendars

A series of excellent scenic colour photographs taken by employees of the company adorn the pages of the calendar received from Associated Electrical Industries Limited, Rugby. The current month is displayed in large type and there are smaller calendars for the preceding and following months on each page. Notes on the pictures are given on the backs of the sheets and on the back of the last sheet there are also complete calendars for 1960 and 1961.

A monthly turn-over desk calendar from Brook Motors Limited, Huddersfield, shows the preceding and succeeding months and, on the reverse, each page has a picture of a Brook motor or of a manufacturing process in the Brook works.

A reproduction in colour of a painting, "On the River Spey", by W. McGregor, is the subject chosen for their calendar by Turner Brothers Asbestos Company Limited, Rochdale. The tear-off calendar shows a month to a page.

A wall calendar from the Midland Electric Manufacturing Company Limited, Tyseley, Birmingham 11, has a portrait in colour that will please admirers of the feminine and the feline. Each page of the tear-off calendar shows the preceding and following months as well as the current month.

The large month-to-a-page tear-off calendar from Mavor & Coulson Limited, Bridgeton, Glasgow SE, carries a picture reproduced from a colour photograph by Mr. C. Hinshelwood. Entitled "Ben Nevis", it shows a view of the mountain over the waters of Loch Linnhe, with a handsome ketch at anchor in the foreground.

A new Hunslet 204 hp diesel-hydraulic locomotive for the sugar industry in Cuba is depicted in colour on the calendar for 1960 of The Hunslet Engine Company Limited, Leeds 10. A month to a page is shown in large type with the preceding and following months in smaller type.

A useful "daily pad" tear-off calendar for either desk or wall comes from Lang Pneumatic Limited, of Wolverhampton, makers of pneumatic control equipment, one of the companies associated with Desoutter Brothers (Holding) Limited.

The attractive custom of well dressing is the subject chosen for their 12-page wall calendar by Edgar Allen & Co. Limited, Imperial Steelworks, Sheffield 9. Each page has a photograph in full colour.

A large wall calendar from A. A. Jones & Shipman Limited, Leicester, manufacturers of high precision machine tools, has a series of attractive reproductions in colour from originals in either water colour or oils by various artists. All are outdoor scenes and appropriate to the seasons.

A large wall calendar from Chloride Batteries Limited, Exide Works, Clifton Junction, Swinton, Manchester, has twelve child studies in full colour, each titled with an allusion to the properties of Exide and Drydex batteries.

Dry Type Air Filter

Data useful to engineering designers are given in a new leaflet issued by The Visco Engineering Company Limited, Stafford Road, Croydon. Included are resistance and efficiency curves of the new "MV" dry type air filter. The filter is of the cell type, each cell containing a "throw-away" pad.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning MECHANICAL WORLD ***when writing to the firms concerned.***

Turret Punching Press

The short production times described in a new brochure on the British Wiedemann turret punch press will interest all concerned with the production of pierced work, particularly in cases where runs are short and modifications are frequently made. The brochure is available from Dowding & Doll Limited, 346 Kensington High Street, London W14.

Electronics for the Graphic Arts

Up-to-date information on a complete range of electronic controls for use with colour printing machinery is given in a brochure issued by J. F. Crosfield Limited, 2 Elthorne Road, London N19. Details are given of the Scanatron, a new colour scanner, and of the Gammatron, the only available equipment for the controlled development of photographic materials which is independent of time and temperature factors.

Compressed Air Equipment

Victor Products (Wallsend) Limited, Wallsend-on-Tyne, have assembled illustrated descriptions and particulars of all their compressed air equipment in a new catalogue, No. CA 100. Included are their Aridifiers (air dryers), water traps, hose couplers, and self-cleaning air filters.

Pipework Fabrication

A 24-page brochure from Charlton, Weddle & Co. Limited, Manors Works, Newcastle upon Tyne, illustrates the great variety of their pipework fabrication, and also installation work in both marine and industrial fields. Heating coils are made in cast iron, steel and non-ferrous alloy, and notable among the various forms are the conical coil and the "Integron" low fin tube.

Induction Motors

'English Electric' high-torque, high-slip squirrel-cage induction motors have been specially designed for applications involving high inertia and frequent load changes, e.g., fly wheel equipped machine tools such as shears, press brakes, drop stamps, etc. The range is from 1 hp to 20 hp. Full details are given in publication DM/257 newly issued by The English Electric Company Limited, Industrial Machines Department, Bradford.

Small Gas Turbines

A 24-page, two-colour publication from The English Electric Company Limited, Gas Turbine Department, Whetstone, Nr. Leicester, describes the smallest in the present range of 'English Electric' industrial gas turbines. The 'EM 27' is a compact two-shaft, open cycle unit, designed to burn a number of fuels, and is suitable for driving fixed or variable-speed machinery in industrial, traction and marine applications.

Cold Caulking Compounds and Wallplugs

Spigot and socket pipes and the joint grooves of tunnel sections require to be caulked. Philplug cold caulking compounds, consisting of asbestos and cementatious materials, enable this to be done cold. The properties of the compounds are set out in a new leaflet available from Philplug Products Limited, Wembley, Middlesex, who have also recently issued a new leaflet describing their "Adapta" wallplugs which are made in four sizes to take all sizes of screws from No. 6 to 16.

Hymatic-Hydrovane Compressor

A leaflet describing the Hymatic-Hydrovane portable compressor type 72P has been issued by The Hymatic Engineering Company Limited of Redditch, Worcs. Essentially an economical highly portable one-tool compressor, the 72P is basically a towable version of the 98P100 Hydrovane mobile compressor. The compressor unit gives an output of 72 cfm at 100 psi which does not fall off with use. The compressor is completely equipped, including overrun brakes, and can be towed behind any light vehicle.

Willison Automatic Coupler

The Willison automatic coupler is of the interlocking vertical plane type and its design is such that railway cars fitted with it can be reversed without "handling". For mining, quarrying and similar activities it has the advantage of a wide gathering range which allows of automatic coupling even under extreme curve conditions and of different heights of car. The coupler is fully described in a new technical brochure available on request from Mr. G. H. Fisher, Publicity Manager, English Steel Corporation Limited, River Don Works, Sheffield 9.

[*Continued over*]

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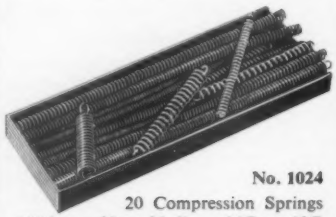
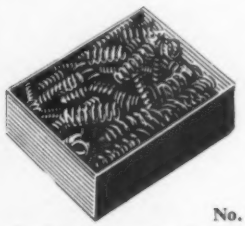
Just one example of the kind of thing we make supremely well. Immediate delivery of all sizes from stock. Sample & price list free.

You're sure to find the very spring you want in Terry's Boxes of Assorted Springs

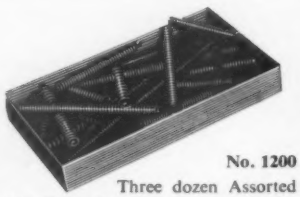


No. 1024
20 Compression Springs 12" long. $\frac{1}{8}$" to $\frac{1}{2}$" diam. 24G to 18G suitable for cutting into shorter lengths; and 3C Expansion 1$\frac{1}{2}$" to 12" long. $\frac{1}{16}$" to $\frac{5}{8}$" diam., 22G to 16G. **24/- each.**

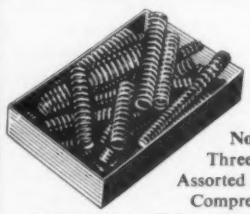


No. 757
Extra Light Compression, 1 gross Assorted, $\frac{1}{4}$" to $\frac{3}{16}$" diam. $\frac{1}{2}$" to 2$\frac{1}{2}$" long. 27 to 19 S.W.G. **15/- each.**

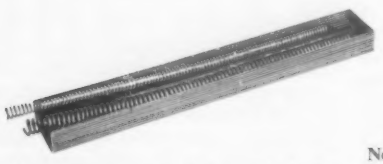
No. 761
1 foot lengths Expansion Springs suitable for cutting into shorter lengths. Assorted diameters from $\frac{1}{8}$" to $\frac{1}{2}$" and 24 to 16 S.W.G. **7/6 per box containing 1 dozen lengths.**



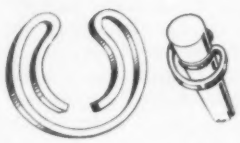
No. 1200
Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



No. 760
Three doz. Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G. $\frac{1}{4}$" to $\frac{1}{2}$" diam. **6/6 each.**



No. 762
1 foot lengths Compression Springs suitable for cutting into shorter lengths. Assorted diameters from $\frac{1}{8}$" to $\frac{1}{2}$" and 24 to 16 S.W.G. **4/6 per box containing 1 dozen lengths.**



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HT38

Radiation Geared Units

Crofts "Radiation" combined spur and worm double reduction gear units are made in twelve sizes which cover powers up to 60 hp and ratios from 300 to 30:1. This is the standard range, but larger sizes and higher ratios are also made for special requirements. Complete data concerning these units is contained in a new catalogue (Publication No. M.W. 758) now available from Crofts (Engineers) Limited, Bradford, Yorkshire. Tables are included of service factor and horse power, casing and shaft dimensions, shaft machining limits, exact speed ratios, and lubrication data.

New Factories

Blaydon (Co. Durham). R. Rankin and Sons Limited, haulage contractors, Ouse Street, Newcastle upon Tyne. Oil storage buildings proposed. The builders are Purdie Lumsden & Co. Limited, 25 Oxford Street, Newcastle upon Tyne.

Boyd and Company (Metal Workers) Limited, Leazes Lane, Newcastle upon Tyne, are to erect factory, offices, and canteen at Chain Bridge Road, Blaydon. Plans by Wetherell, Lamb and Partners, 24 Picton Place, Newcastle upon Tyne have been approved by the local authority.

Carlisle. Robinson Transport (Carlisle) Limited, Etterby Lea Grove, are to erect a transport depot on the Newtown trading estate.

Consett. Carricks (Caterers) Limited, 47 Grey Street, Newcastle upon Tyne, are to erect a transport depot of 3,500 sq ft in Gibson Street, and outline plans have been approved.

Crawcrook (Co. Durham). North-Eastern Electricity Board, Carliol House, Newcastle upon Tyne. The architects for proposed offices, workshops and stores are L. J. Couves and Partners, Grainger Chambers, Hood Street, Newcastle upon Tyne.

Durham. The N.C.B. have accepted the tender of Holland, Hannen and Cubitts, Limited, Howdon-on-Tyne for the erection of divisional stores at Lambton, Co. Durham. The cost will be £220,000. Plans by the N.C.B. Architects' Dept., 24 The Side, Newcastle upon Tyne.

Middlesbrough. Middlesbrough Casements Limited. Plans have been approved for proposed offices. The builders are Stephen Coates Limited, North Ormesby, Middlesbrough.

Rothbury. J. W. Capstaff Limited, haulage contractors, Benton, Newcastle upon Tyne, are seeking a site at Rothbury on which to erect repair and maintenance shops, stores, and offices.

South Shields. A. L. Surtees, paper bag maker. A factory at Laygate is to be erected by Atcost Limited, 66 Duke Street, Darlington.

Murray Hearne Limited. A printing works is to be erected by Atcost Limited.

Wright and Weaire Limited. The architects for enamelling shop at the Simonside Works are Newrick and Blackbell, 58 John Street, Sunderland.

Stockton-on-Tees. Head, Wrightson and Company Limited are to erect new drawing offices, planning and erection departments at their Stockton Forge Works.

Serck Radiators Limited, Skinnerburn Road, Newcastle upon Tyne, are to construct a factory 120×25 ft for making and repairing motor car radiators, on North Tees Industrial Estate. Tenders are expected to be obtained shortly. The architect is J. G. L. Poulson, 54 Albert Road, Middlesbrough.

Sunderland. Frucose Limited. Mineral water factory proposed at Westbourne Road. The architects are G. T. Brown and Son, 53 Fawcett Street.

Petrofina (Great Britain) Limited, 25 Victoria Street, London, SW1, are to extend their oil installation at the Corporation Quay. The work will include new storage tanks, new pump house, new vehicle loading bays, rail car loading gantry, offices, lubricating stores and vehicle maintenance facilities.

Jackson Associated Manufacturers Limited, clothing manufacturers, Leeds, are negotiating for a site in Wear Street, Sunderland for the erection of a factory to cost £250,000. The architects are Stephenson Gillie and Partners, Saville Chambers, North Street, Newcastle upon Tyne.

W. & T. Avery, Limited weighing machine manufacturers. Workshop, offices and showroom at Nile Street. Plans have been prepared by Marshall and Tweedy, 36 Blackett Street, Newcastle upon Tyne.

Tynemouth. Smith's Dock Company Limited, North Shields, are to spend £1,250,000 on developments at their North Shields repairing yard. No. 4 dry dock is to be widened and lengthened, and a new dock built on the site of the No. 3 dock. It is proposed to close No. 7 dock and erect a new plumbers' and boilermakers' shop on the site.

Bangor, N. Ireland. The Kenwood Company Limited, Eckington, Chesterfield. To erect new factory.

Bolsover. Bolsover Hosiery Company Limited. To extend factory.

Bootle. A.B.C. Polythene Company Limited, 4 Batchelor Street, Liverpool. To erect new factory at Park Lane, Netherton.

Bournemouth. Max Factor Limited, Francis Avenue. Plans submitted for extensions to factory.

Bradford. J. L. Tankard & Co. Limited, Broad Lane. To extend factory.

Brighouse. J. Blakeborough & Sons Limited. To make factory extensions.

Brighton. Cornelia James Limited, Havelock Road. Factory to be extended.

Burnley. The Barden Mill Company Limited. To make extensions.

Cardiff. British Oxygen Company Limited. The architects for extensions are R. Towning Hill & Partners, 18 Orchard Street, Bristol.

Church. Rishy Crisps Limited. Plans have been approved for extensions to works.

Coventry. W. W. Curtis Limited, Cheylesmore Press, Charter Avenue. To erect new factory; the architects are W. S. Hattrell & Partners, 1 Queens Road.

Coventry Climax Engines Limited, Godiva Works, Widdrington Road. Plans approved for extensions to factory at Sandy Lane.

Cumnock. John Foster & Son Limited. Bankhead Mills to be extended.

Dagenham. J. Dore & Co. Limited, 30 Bromley High Street, London, E3. To build new factory and offices at Romford Road.

Dundee. Bristol Tool & Gauge (Scotland) Limited, Crews Hole Road, St. George's, Bristol. Contractors for new factory are J. B. Hay & Co. Limited, Guthrie Street.

Eastbourne. A. H. Hunt (Capacitors) Limited, Bendon Valley, London, SW18 are interested in a site for a new factory.

Enfield. The Enfield Rolling Mills Limited, Millmarsh Lane. To make extensions to works.

Grangemouth. Union Carbide Company, B'ness Road. Permission received to erect new factory.

Havant. Kenwood Manufacturing Company Limited. Permission received for the erection of new factory.

Hereford. Saunders Valve Company Limited. Plans for the erection of an engineering machine shop at Blackfriars Street prepared by R. W. Powell & Son, 301 Kings Acre Road.

Hyde. Richard E. North & Co. Limited, St. Paul's Street, Newton. Extensions to works.

Leigh. Uniproducts (Manchester) Limited and Latham Engineering Company Limited, Albion Mill, Warrington Road, Glazebury, are to convert the Newchurch Hall into a workshop.

Liverpool. James Austin Limited, Speke Hall Road. To erect a new factory at Gaskell Road, Speke Industrial Estate.

London. W. Phillips & Co. (Preserves) Limited, 2 Janson Road, London, E15. The architects for works extensions are Gooch & Wagstaff, 4 Old Jewry, London, EC2.

Booth & Driver Limited, 16 Oakleigh Road North, London, N20. To erect new factory at Whetstone.

Luton. Barclay Stuart (Plastics) Limited, Brunswick Street, propose extensions.

Manchester. J. W. Richards & Sons (Manchester) Limited, 26 Bridge Street. Plans approved for the erection of new light engineering works at Water Street.

Mansfield. Mansfield Hosiery Mills Limited, Botany Avenue. Factory extensions.

Matlock. Paton & Baldwins Limited. Extensions to be made to the works at Derwent Mills.

Mitcham. Beck & Company (Meters) Limited, 53 Lillian Road, London, SW16. Approval received for extensions to works.

Nuneaton. Slater & England Limited, 5 Warwick Street, Coventry. To build new factory at Pool Road.

Petersfield. Calibrated Papers Limited, Swan Lane. The contractors for new factory are Gardner & Co. Limited, Bordon, Hants.

Plymouth. Bush Radio Limited, Ernsettle Industrial Estate. Extensions to works.

Portchester. Chapman of Trowbridge Limited, Trowbridge. To erect new factory off East Street.

Salford. Lewsons Clothing Company Limited, Chapel Street. Factory extensions.

Smethwick. Birmingham Aluminium (1903) Limited, may extend their East Works, Dartmouth Road.

Wigan. Dunlop Cotton Mills Limited, Kirkpatrick Mills, Hindley Green. Modernization scheme.

Glasgow. The Scottish Co-operative Wholesale Society Limited are to erect a two storey extension to their printworks at Shieldhall.

Textile Engineering Company of Glasgow have received planning permission in principle for the erection of a light engineering works at Drakemire Drive.

M. Ferrar & Sons Limited, of 157-163 Millerfield Road, are to make an extension to their factory.

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18 FT × ½ IN. RHODES PRESS BRAKE for sale (or 10 ft × $\frac{7}{16}$ in.) 150 tons capacity. Motorised 400/3/50. Friction clutch. Motor adjustment to ram. 90° forming tool, 10 ft 2 in. long, and bottom die with 1¼ in. and 1½ in. openings. Bed and top beam solid steel, 18 ft 1 in. long. Between uprights 10 ft 2 in. Stroke 5 in. Die space 12 in. Weight about 20 tons. F. J. Edwards Limited, 359, Euston Road, London, NW1 or 41, Water Street, Birmingham, 3.

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Patents For Sale or License

THE proprietor of Patent No. 757549 for "A multi-speed Gear Change Mechanism" desires to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Company, 28 Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of British Patent No. 761002, entitled "Method and apparatus for casting metal battery parts" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Calberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 757181 entitled ,'Improvements in Screw Anchorages," offers same for license or otherwise to ensure its practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, Chrysler Building, New York 17, New York, U.S.A.

THE proprietor of British Patent No. 760453, entitled "Improvements in shaft sealing devices" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 657949, entitled "Flareless Tube Coupling" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 737352, entitled "Cable Spool Winding", offers same for license or otherwise to ensure practical working in Great Britain.

Classified advertisements are inserted at the rate of 3/- per line.

Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 759067, entitled "Wide Throat Press", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinios, U.S.A.

THE proprietors of Patent No. 613055 for "Improvements in or relating to Methods of Infolding and Machines therefor" desire to secure commercial exploitation by Licen e or otherwise in the United Kingdom. Replies to Haseltine Lake & Company, 28 Southampton Buildings, Chancery Lane, London WC2.

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U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

The following engineering vacancies are currently available at the Avonmouth Works and in Group Departments on the Avonmouth Site:

AVONMOUTH WORKS

Assistant Area Engineer
Duties involve controlling work done by tradesmen and labourers on zinc blast furnace and associated plant, including provision of spares, operation of bonus schemes, and general supervision of engineering maintenance work. An apprenticeship, preferably in heavy engineering and professional qualification or degree in Mechanical Engineering essential. Previous experience in a supervisory capacity in heavy chemical or metallurgical industry is desirable. Age limits 23-35. Ref. ME/ENG/70.

CHIEF ENGINEER

Engineering Assistants
Opportunities to train for future engineering posts of responsibility exist for two young men with a university degree or Higher National Certificate in Mechanical or Chemical Engineering. Mobility is important since the persons appointed may be required to work for indefinite periods at any of the seven Works Sites. Ref. ME/ENG/71.

Group Mechanical Engineer
One of a team of design engineers who are collectively responsible for the detail design work arising out of capital expenditure projects at any of the Corporation's Works and for following the projects through to their completion, including procurement and construction. A university degree or professional qualifications in Mechanical Engineering will be required, together with sound design experience—preferably in heavy engineering. Ref. ME/ENG/72.

Draughtsmen
For the development of schemes and detailing of equipment to guide invitations to tender and the manufacture of plant. At least five years' experience—preferably in heavy engineering—is required and preference will be given to candidate holding N.C. or H.N.C. in Mechanical Engineering. Ref. ME/ENG/73.

IMPERIAL SMELTING PROCESSES LIMITED

Design Engineer
A qualified engineer, preferably with a first class honours degree and sound experience, including design in the heavier type of engineering, is sought. Duties are to participate in the design and development of blast furnaces and ancillary plant for the Imperial Smelting Process and in this instance fluency in both written and spoken German is very desirable. Ref. ME/ENG/74.

Applications, quoting the reference(s) of particular interest and giving brief details of qualifications and experience should be addressed to:

CZC

Personnel Manager

IMPERIAL SMELTING CORPORATION LIMITED

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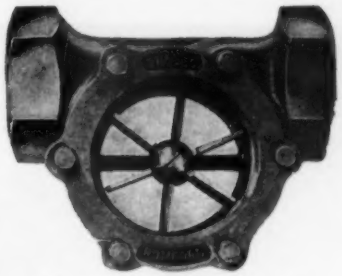

Fig. No. 408 Spinner Type for vertical or horizontal pipelines

B. RHODES & SON LIMITED

QUEEN STREET, ROMFORD, ESSEX

Telephone: ROMFORD 62333/4

A 75

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HIGH PERFORMANCE AT LOW COST

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This new design has a much higher discharge capacity than ordinary type safety valves.

SNAP RESEATING

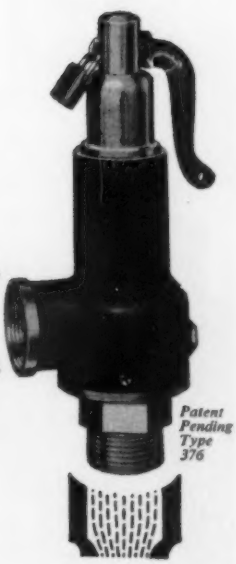
The valve reseats without "feathering". The pressure at which the valve reseats can be controlled by an adjustable blow-down ring.

Discharge is equally prompt.

SIZES AND PRESSURES

Sizes from ½" to 4" up to 250 lbs. per square inch saturated steam.

The valves are all gunmetal or fitted with nickel alloy valves, seats and stainless steel spindles, are to Insurance Company requirements and comply with relevant British Standard Specifications.



Patent Pending Type 376

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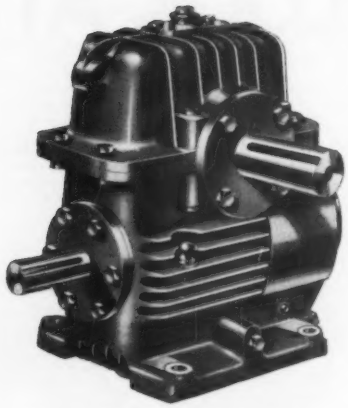

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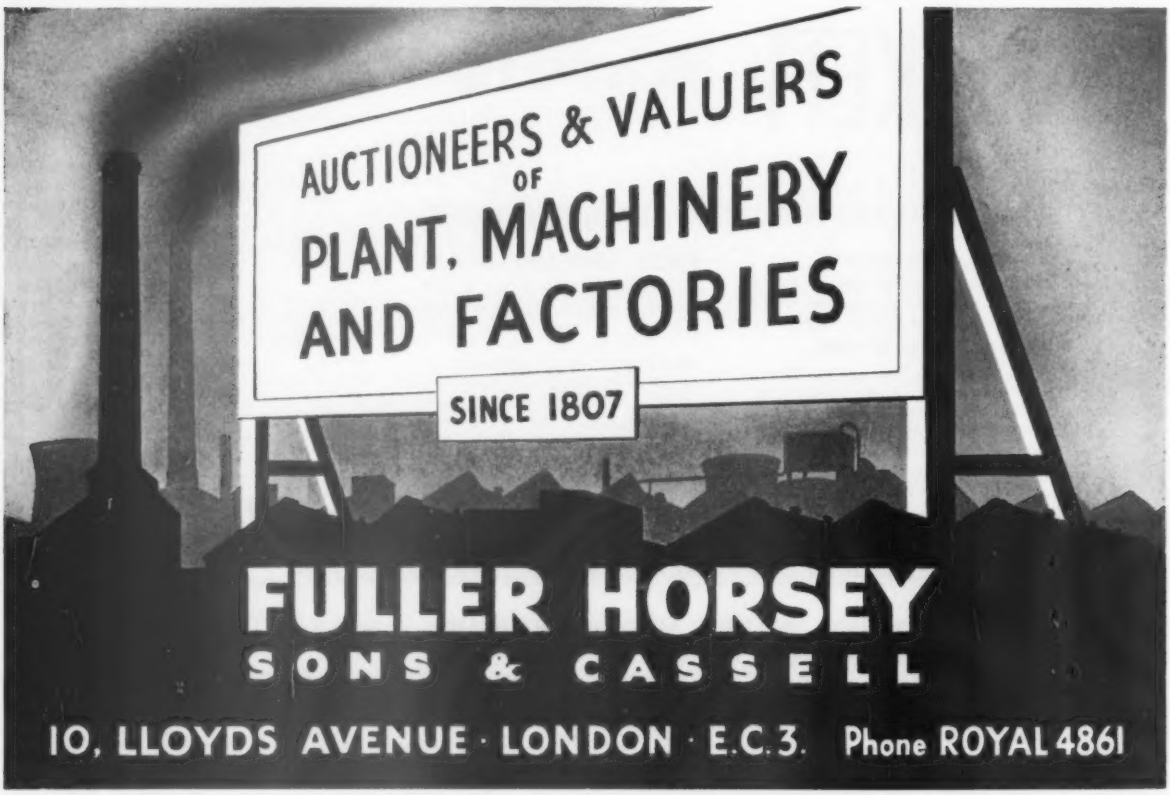

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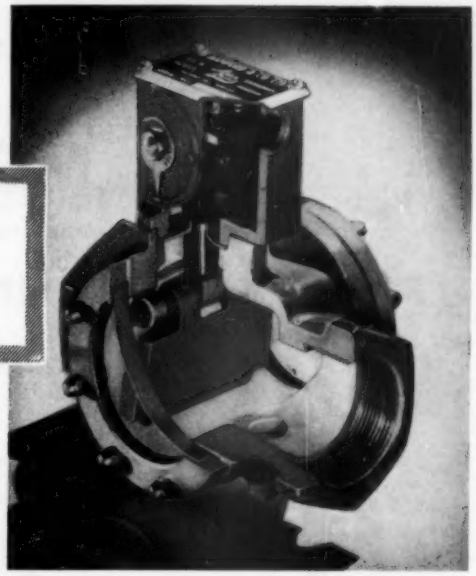

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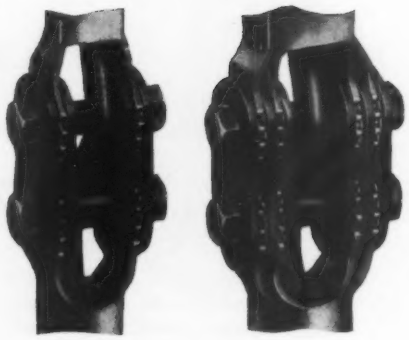

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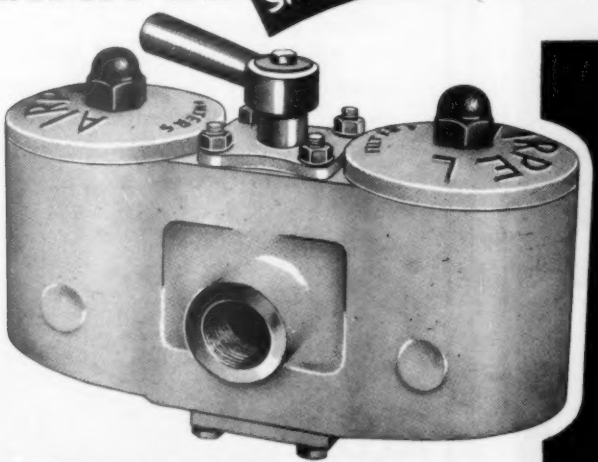

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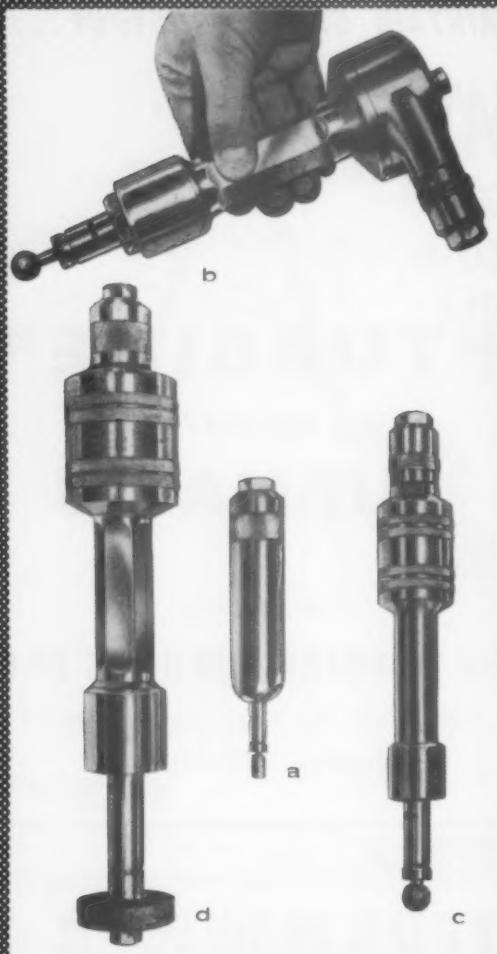

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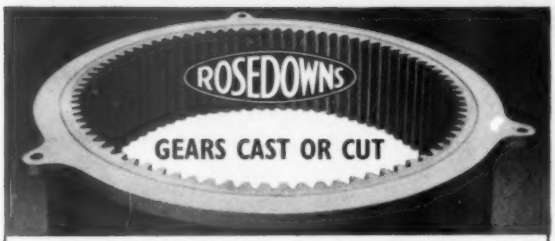

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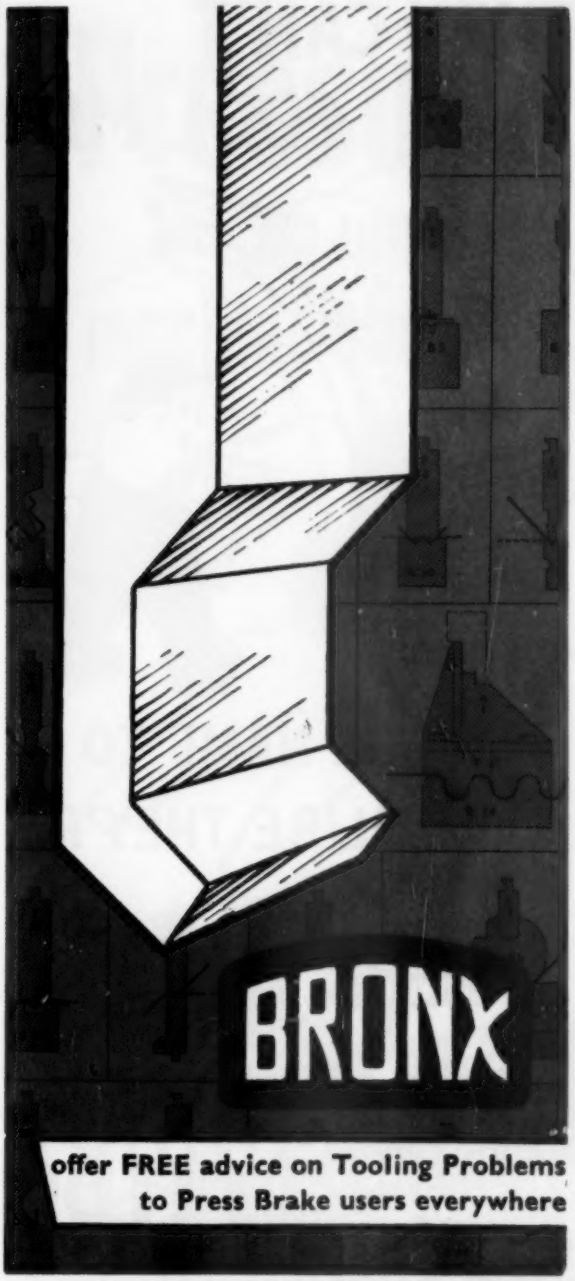

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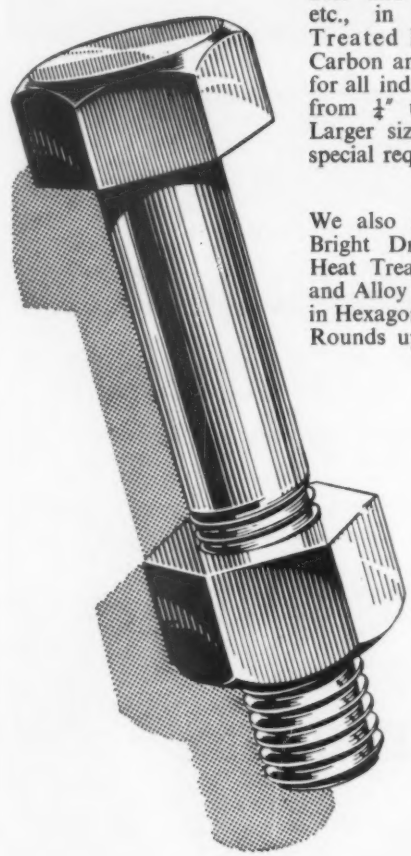

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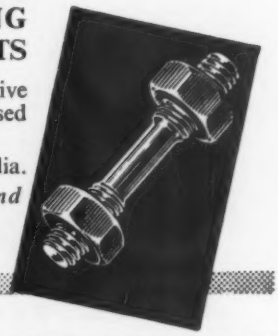

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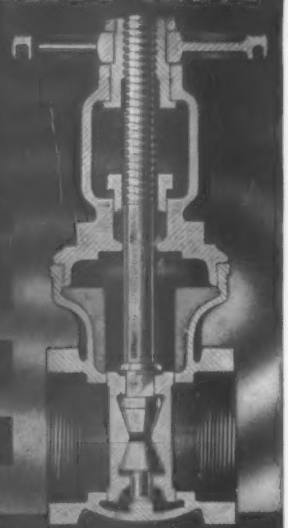

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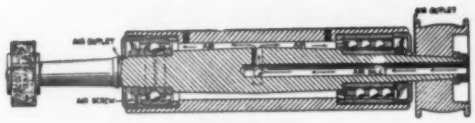

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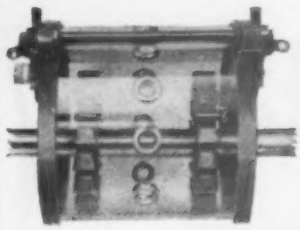

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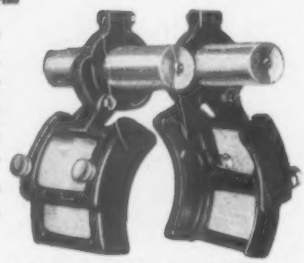

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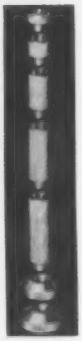

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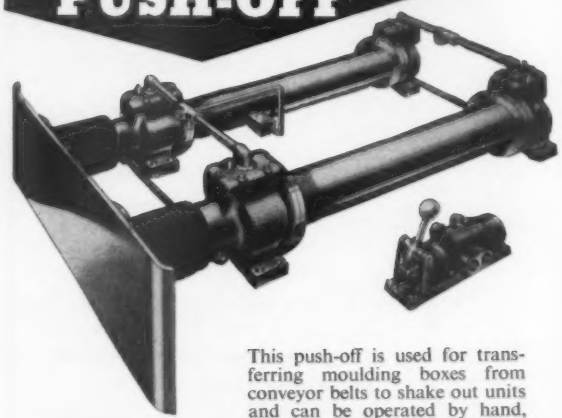

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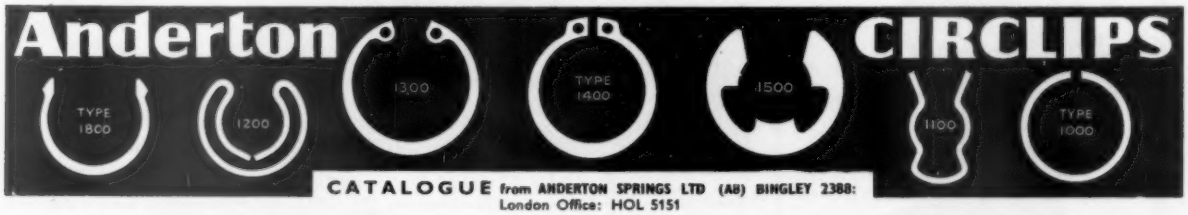

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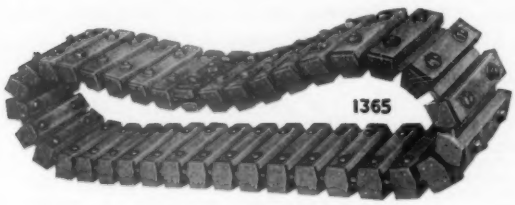

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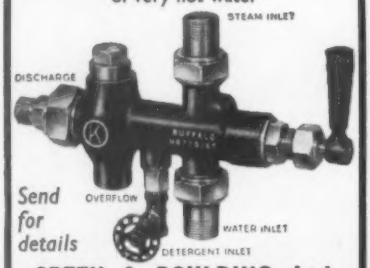

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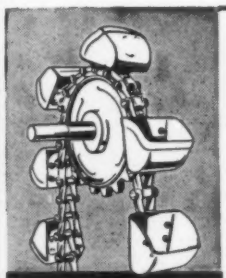

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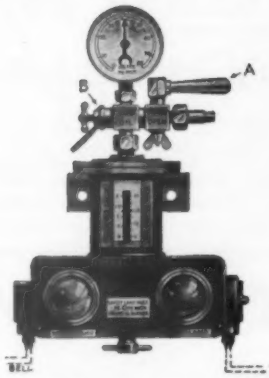

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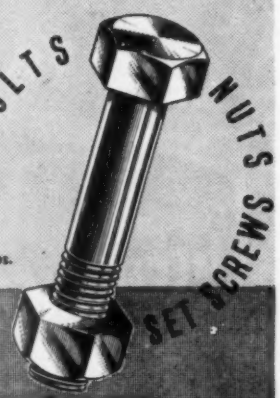

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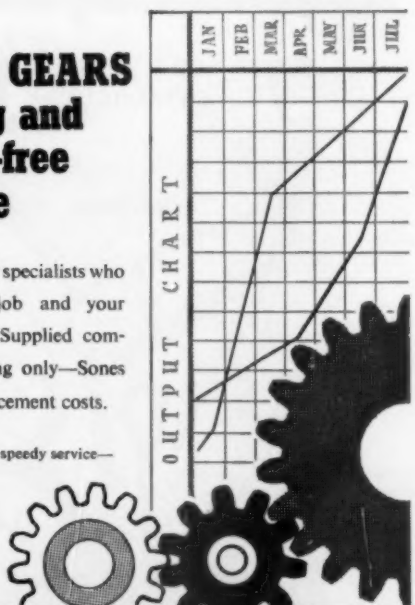

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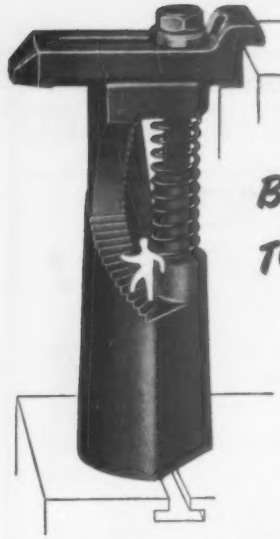

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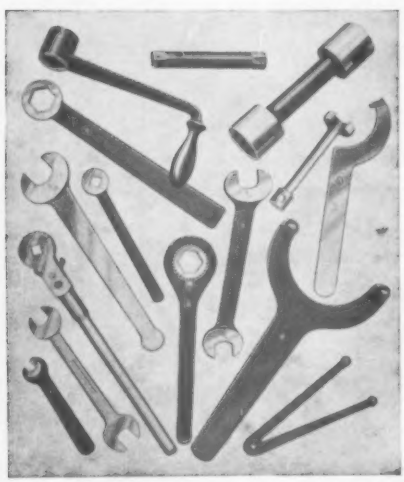

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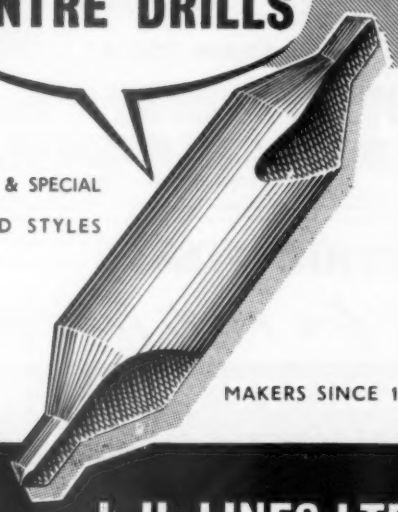

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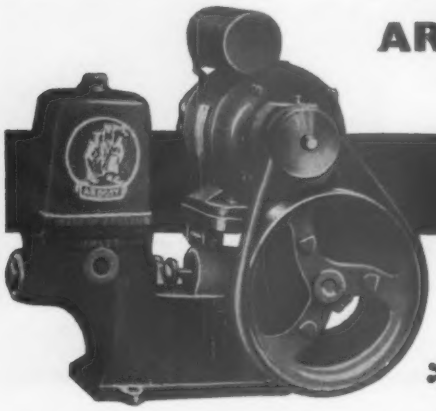

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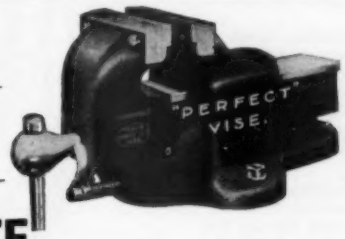

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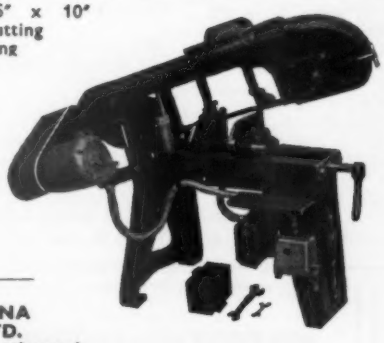

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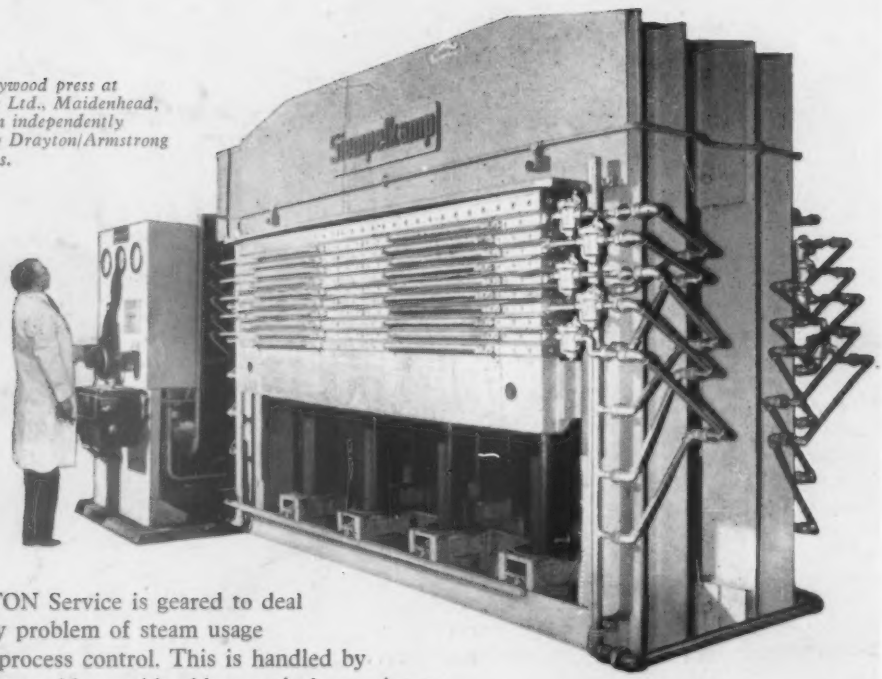

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